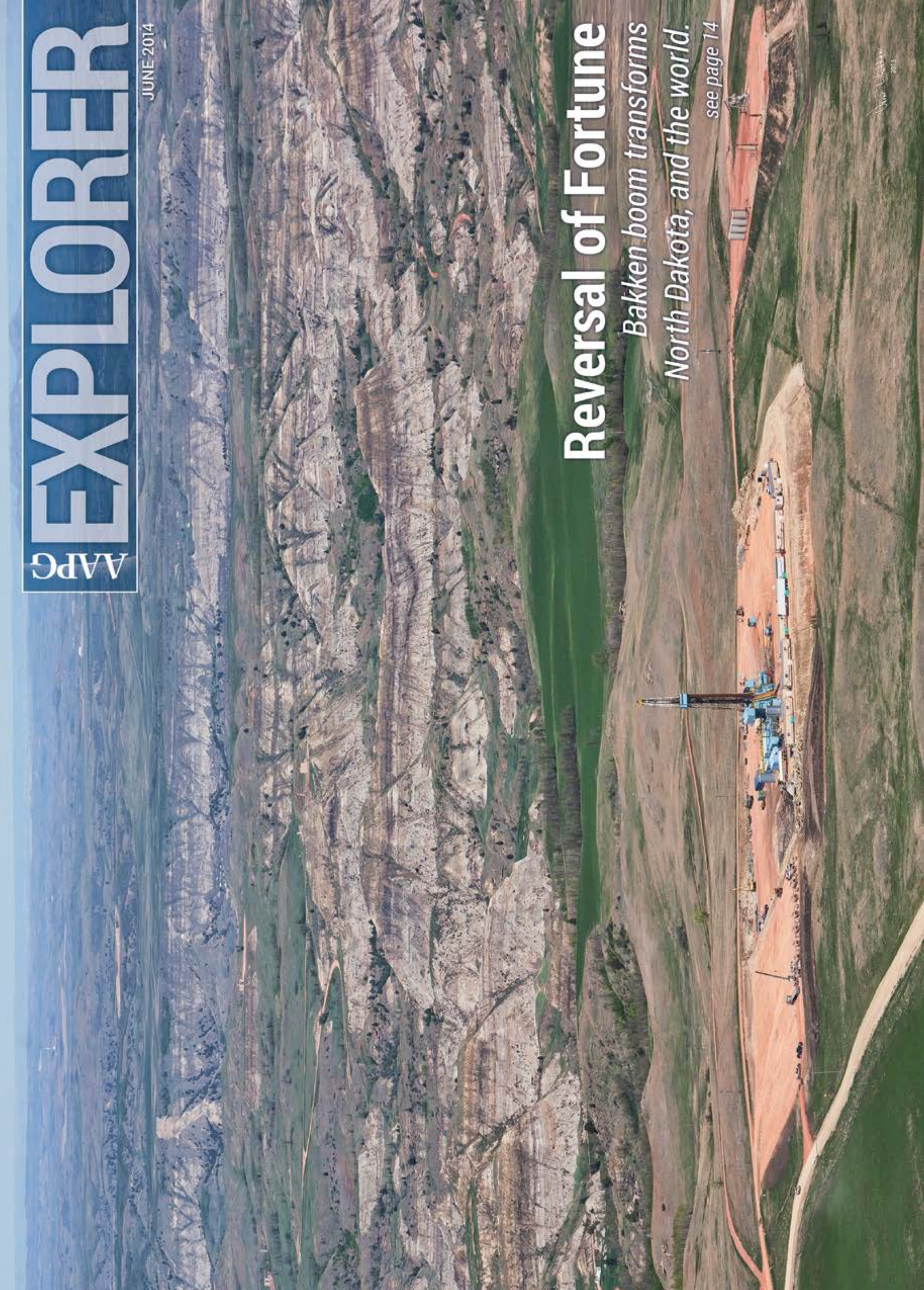


Reversal of Fortune

Bakken boom transforms North Dakota, and the world.

see page 14

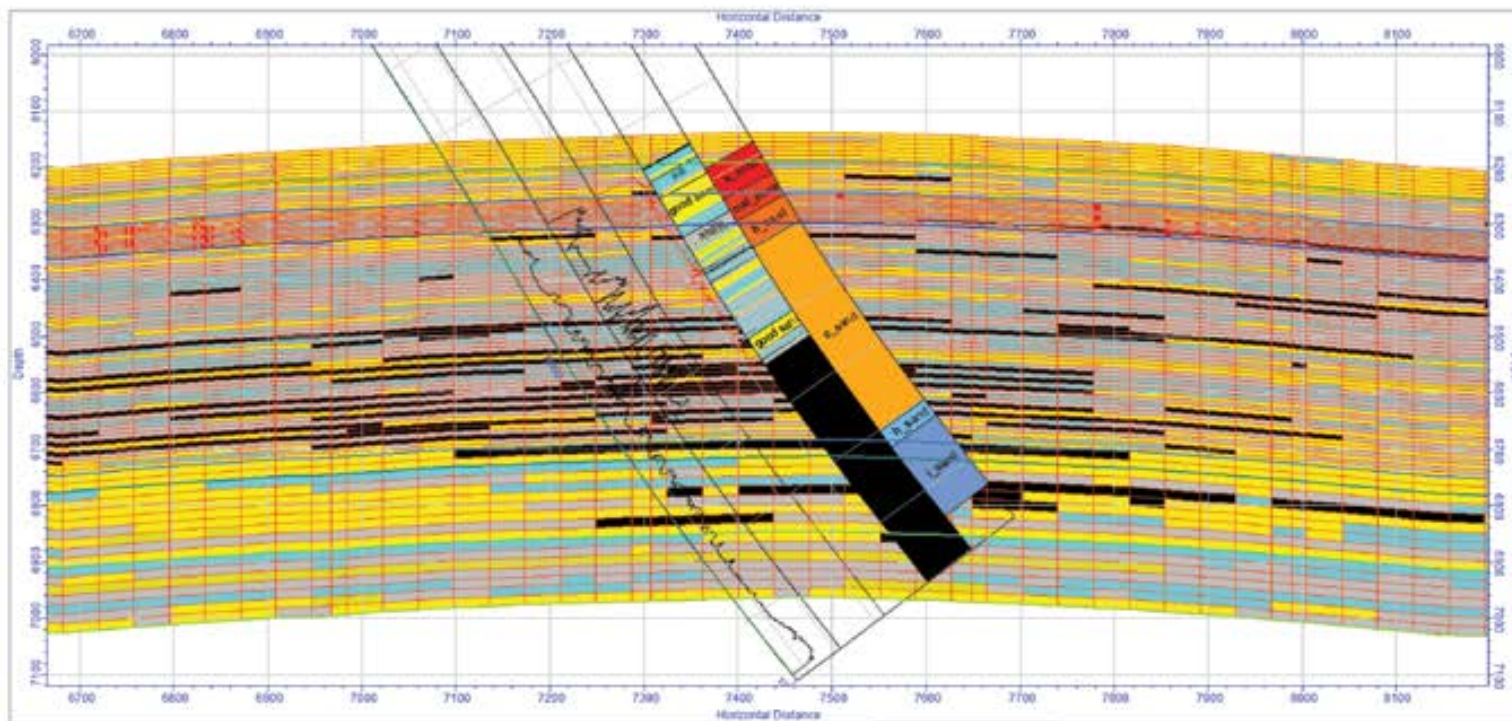




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PRESIDENT'S COLUMN

Doing What We Said We'd Do – Well, Did We?

BY LEE F. KRYSZNIK

The end of the "doing what we say we do" theme has arrived – but not the end of doing what we say we will do at AAPG!

Well, much as promised by my predecessors, the year indeed has flown by quickly and this is my last column to you as president. Soon, I will find myself with more time to explore for oil and gas and get back to riding my horse – if he still recognizes me.

So did we actually accomplish what we set out to do this year?

This year's Executive Committee addressed a broad range of items and we accomplished most of our goals:

► **DEO-GIS** – Though we hope the name will change to something more reflective of what a cool system it is, DEO-GIS (Datapages Exploration Objects) is a map-based portal into all past AAPG publications, largely for corporate clients.

With it, users have the ability to quickly find any map, cross-section or other exploration element and download it to their own desktop already in a GIS georeferenced or geolocated format.

This AAPG Datapages product ties in with our effort to make Datapages more profitable on behalf of AAPG. It is being rolled out to sales and will continue to be expanded as we head toward our 100th anniversary.

► **Three-Year Business Plans** – Three-year business plans, tied to AAPG's long-term strategy, are almost complete and will be presented to the Executive Committee as I depart.

The next near-term step is to understand the fiscal impact of each component of the rolled-up business plan and allocate resources and plan budgeting accordingly.



KRYSZNIK

We must work much more effectively at showing our relevance within geoscience – perhaps most especially to the public.

► **Advisory Council Initiatives** – The AAPG House of Delegates reached a consensus and passed a revision of the sponsorship requirement, reducing it to one sponsor, and membership application forms have been changed accordingly, along with an inclusion of the AAPG Code of Ethics for all applicants and renewing members.

Other initiatives are under study and some may be brought forward next year.

► **Fiscal Responsibility** – Keeping AAPG fiscally viable is a key effort in every term. For example:

✓ The Imperial Barrel Award is one of our most popular programs, but also the most costly, thus highly sensitive to potential downturns in industry sponsorship.

Contingency plans have now been put in place to keep the program alive and functional in the event of tight financial times.

✓ The 100th Anniversary Committee's planning efforts are now much more focused and we expect to see clearly defined budgets by our last EC meeting in June.

✓ Our financial buffer had fallen to nine months of operations, and our goal was to expand that buffer.

Here's the good news: This year we will be moving \$750,000 out of our operating funds and into our investments portfolio.

I offer congratulations to all of our volunteers and staff who have worked so diligently to create this additional surplus!

► **Cooperative Efforts with Our Sister Societies** – The Unconventional Resources Technology Conference (URTeC), International Petroleum Technology Conference (IPTC) and Offshore Technology Conference (OTC) all represent very successful and ongoing joint efforts with other societies like SPE, SEG and EAGE.

The effort to expand our cooperative efforts will continue in response to our membership and the sponsoring companies who are requesting more fully integrated technical meetings.

Incidentally, I was reminded by the OTC technical committee that the call for papers for the next OTC will be issued as this column is printed, and I encourage anyone working in the offshore arena to contribute an abstract – it is a fantastic technical venue to showcase your geoscience!

► Though the EC can claim no credit, AAPG's **new website** also has been rolled out this year. It is a giant leap, initiating a long journey forward – and we appreciate the diligent and ongoing efforts of our staff in this huge endeavor!

There are many other bits and pieces

of daily business that have been dealt with, but these are some of the larger issues addressed by the EC this year.

I wish to thank **Randi Martinsen**, our president-elect, along with **Richard Ball** (secretary), **Tom Ewing** (vice president-Sections), **John Kaldi** (vice president-Regions), **Deborah Sacrey** (treasurer), **Mike Sweet** (editor) and **Larry Wickstrom** (HoD chair), who all served on this year's EC with distinction, hard work and exceptional professionalism. They have done a great job for AAPG this year!

Huge thanks also to **David Curtiss**, executive director, **David Lange**, deputy executive director, and the people of our wonderful **AAPG staff** for all of their hard work, day in and day out!

* * *

What about new challenges to be tackled?

► **Inclusivity** – AAPG no longer is just a North American organization, and we must continue to reach out to geoscientists across the globe, to share our science and our approach to professionalism.

This also means open acceptance of the fact that we will learn as much or more than we share – and these experiences will make AAPG far better.

Opportunities abound for us to include more young professionals, women and people of all backgrounds from around the world, and we should do so!

► **Unity** – AAPG comprises approximately 40,000 people from 118 different countries, and we are, by nature, different.

But despite the many different cultures,

[See President, next page](#)

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TABLE of CONTENTS

6 Canary in the Oil Patch: As **Colorado** goes, so goes the nation when it comes to **energy and environmental policy** and the court of public opinion.

10 Balance of Energy: The EXPLORER interviews **Colorado Gov. John Hickenlooper** and others about presiding over the national nexus of **energy and environmental politics**.

14 Reversal of Fortune: With an economy in decline and a population exodus only a few short years ago, **North Dakota** has transformed into a boom state, thanks to the **Bakken formation**.

20 Waiting in the Wings: As the Bakken, Eagle Ford, Marcellus and other shale plays make national news, the **Cane Creek reservoir** might be a dark horse poised to emerge as another major shale play.

26 The Kids Are All Right: Videos made by **AAPG Student chapters** get rave reviews, particularly the work of the **San Diego State University** chapter.

38 Across the Border: A comprehensive look at **Mexico's revolutionary energy reforms**.



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Photo courtesy of Anadarko Petroleum

REGULAR DEPARTMENTS

| | |
|------------------------------|----|
| Historical Highlights | 32 |
| Policy Watch | 42 |
| Geophysical Corner | 44 |
| Regions and Sections | 46 |
| ProTracks | 48 |
| Foundation Update | 50 |
| Classified Ads | 53 |
| Director's Corner | 54 |
| Divisions Report (DEG) | 54 |

ON THE COVER:

North Dakota's Bakken formation stands out among several plays in the United States that have driven the nation's energy boom of recent years and transformed the economies of their surrounding communities. Photo courtesy of Vern Whitten Photography.

Left: Anadarko Petroleum's operation at Wattenberg field, which is among several major production areas in the Rocky Mountains section covered in this month's EXPLORER.

Hogg Voted AAPG President-Elect

John Hogg, an AAPG Honorary member and vice president of exploration and operations for MGM Energy Corp., in Calgary, Canada, has been voted president-elect by the AAPG membership for the 2014-15 term and will serve as AAPG president in 2015-16.

Also elected were:

☐ Vice president-Sections – **Steve Brachman**, vice president of exploration and development, Wapiti Energy, Houston.

☐ Treasurer – **Jim Tucker**, former longtime geologist for Saudi Aramco and now a consulting geologist in Houston.

Both the vice president-Sections and



HOGG



BRACHMAN



TUCKER

Others on the 2014-15 committee – and serving the final year of their two-year term of service – are vice president-Regions **John Kaldi**, Australian School of Petroleum, University of Adelaide, Adelaide, Australia, and secretary **Richard W. Ball**, Chevron, Angola Block O, Houston. Serving the second year of his three-year term is editor

Michael Sweet, ExxonMobil Production, Houston.

Also on the new committee will be **David Dolph**, team lead for global exploration-new ventures, Nexen Energy ULC, Calgary, Canada, who will assume the chair of the House of Delegates. ☐

treasurer will serve two-year terms.

The newly elected officers will begin their duties on July 1, serving on an Executive Committee headed by **Randi Martinsen**, with Hydrocarbon InSight in Laramie, Wyo., who assumes the AAPG presidency.

President from previous page

ways of doing business and geoscience priorities, we share a common bond of passion for geoscience.

We must find ways to communicate much more effectively with AAPG Regions and AAPG Sections. There is little excuse for failure to communicate in this electronic information age, yet we do regularly fail in this effort.

► **Relevance** – Many of us consider AAPG to be of high relevance in our careers, but that relevance may be lost on students and fellow professionals. The science they may be seeking is just a few swipes away on their pads and cell phones.

What makes AAPG so special? And how many of us can tell a layperson, in three sentences or less, why AAPG really matters to them?

One possible answer: We are special because we are a community of professionals, all with passion for applied geoscience. By passionately sharing that knowledge and professionalism within our community we continue to meet the energy needs of global society.

But we must work much more effectively at showing our relevance within geoscience – perhaps most especially to the public, who are sometimes intentionally misinformed by zealous folks who believe things like hydraulic fracturing will unhinge the planet.

I would love to see AAPG more heavily involved in activities like Geoscientists Without Borders, to help the world see that geoscience can help families avoid landslides and tsunamis, or provide children clean water versus a parasite-infested mud hole.



Krystinik has some new challenges to tackle.

* * *

OK, enough rambling from your outgoing president.

We have tried hard to do what we said we would do this year. Some progress, though never enough, was made.

As I hand over the reins to Randi Martinsen, I will ask each of you to please let her know, at RandiMartinsen@aapg.org, how AAPG can continue to better do what we say we will do!

And finally, I offer my warmest thanks to you all!

Now, I think I hear my horse calling from the barn.

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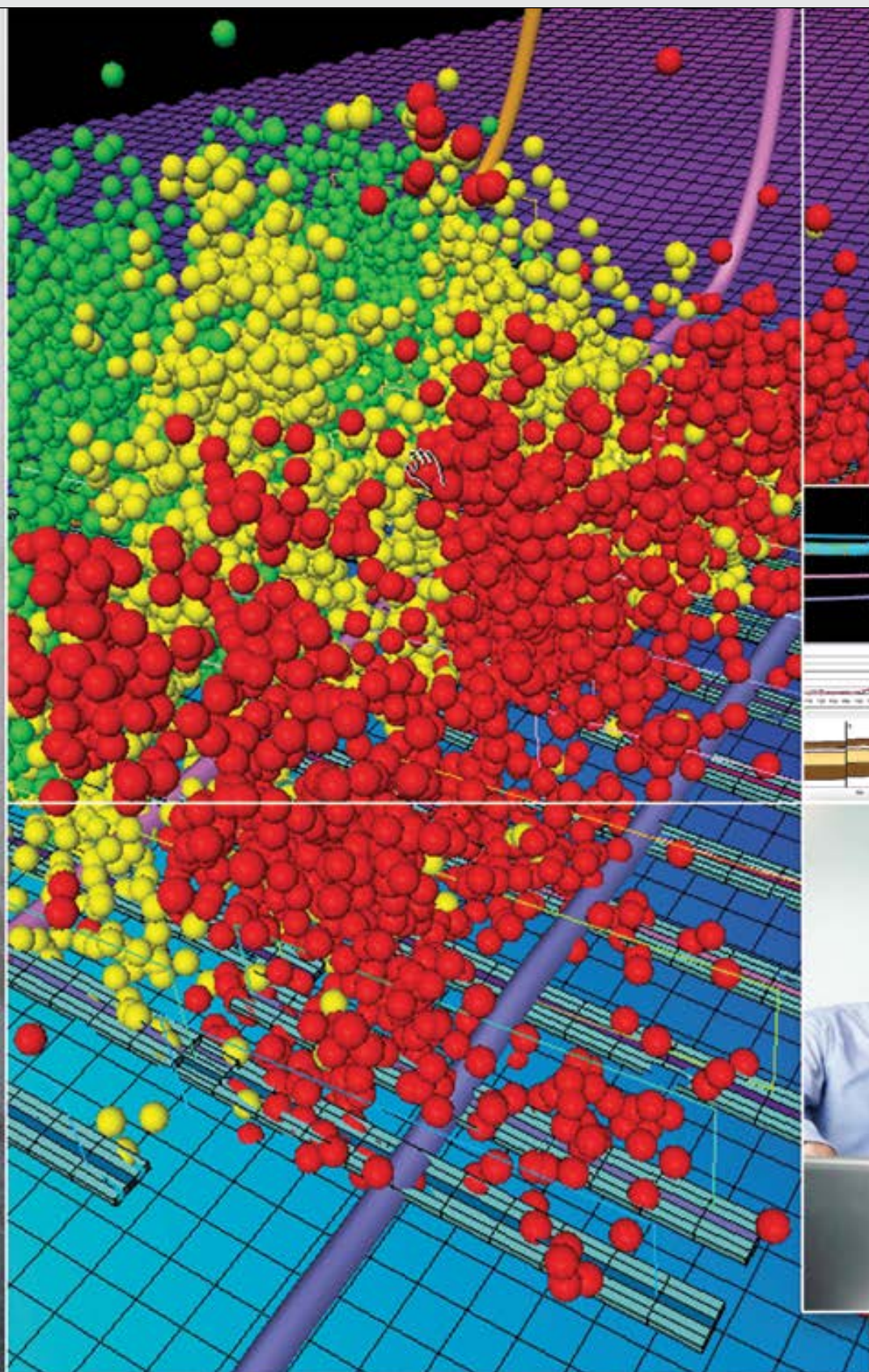
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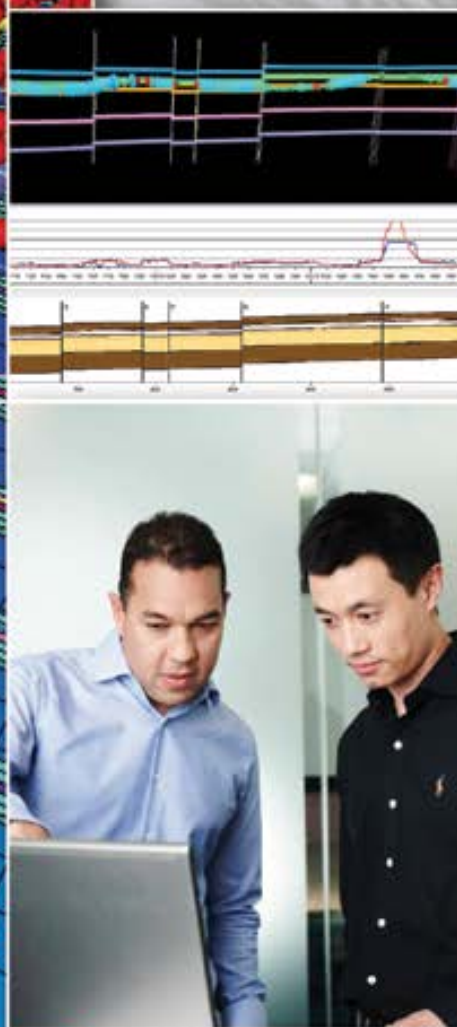
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Production up, but so are challenges

Colorado Crucial to Converging Dynamics

By HEATHER SAUCIER, EXPLORER Correspondent



Five years ago, oil and gas were essentially dead in Colorado. The state's old vertical wells tapped as many reservoirs as technologically possible, and operators all but abandoned the Centennial State for more lucrative frontiers.

These days, Colorado is making a comeback by breaking 50-year records in oil production.

More than 64 million barrels of oil were produced last year, with numbers climbing higher as we speak, according to the Colorado Oil and Gas Conservation Commission (COGCC), which regulates the state's oil and gas industry.

Technological advances in horizontal drilling and multi-stage hydraulic fracturing have enabled operators such as Anadarko Petroleum Corp. and Noble Energy Corp. to return to the Niobrara Shale in northeast Colorado and to the Piceance Basin in west Colorado to recover tight oil and natural gas that once were practically impossible to extract. The boom added nearly \$30 billion to the state's economy last year, including \$1.6 billion in tax revenue, according to the Colorado Oil and Gas Association (COGA).

But all that could soon come to an end.

End of An Era?

As more than 52,000 wells have been pumping more than 175,000 barrels of oil a day from the ground, environmental and community activists have been pumping the public's ears with pleas to ban drilling and hydraulic fracturing – activities they claim are harming the state's pristine landscape and contaminating groundwater.

Heavily funded groups such as Coloradoans for Local Control, backed by the infamous U.S. Rep. Jared Polis – who reportedly became outraged when a drilling rig went up next to his home in Weld County – have received so much public support they are likely to have several initiatives on the November ballot that could ultimately ban drilling, hydraulic fracturing and other industry-related activities in the state, said Doug Flanders, director of Policy and External Affairs for COGA.

If passed, the initiatives could strip the state's authority to regulate the energy industry – and other industries for that matter – and hand that power to cities and counties. Five communities in Colorado already have voted to ban hydraulic fracturing for five years in their city limits – an action that landed two of the cities in court, sued by Colorado Gov. John Hickenlooper (see related story, page 10).

Countless commercials, tweets and posts from anti-fracing groups are running rampant through social channels, forcing industry leaders and the politicians who

support them – including Hickenlooper, a Democrat, former AAPG member geologist and industry supporter – to quickly set the record straight before the state's highly-publicized election in November.

"The energy industry has made huge investments of billions of dollars here, and it could all go away with one vote," said AAPG member Catherine Campbell, a geologist for Robert L. Bayless, Producer and AAPG Rocky Mountain Section secretary/treasurer.

"That's beyond scary for the state of Colorado," she continued. "Some of the ballot initiatives affect not only oil and gas but so much more as well. A lot of industry is in Colorado. The beef industry is in northern Colorado and the Coors brewery is in Golden. There are smoke stacks there and a consistent smell, but that's part of Golden."

State leaders, oil and gas operators and the community at large are scurrying to understand new proposed legislation before the November vote that may change state regulations about drilling. The legislation seeks to define a balance between the need for developing Colorado's hydrocarbon resources and community safety and environmental sensitivities. If successful, Colorado could become a bellwether state for

others struggling with similar issues, said AAPG Honorary member R. Randy Ray, a consulting geologist/geophysicist of Denver-based R3 Exploration.

"Colorado has been at the forefront of the energy debate. The balance of energy and environment comes to a head here," Ray said. "We have such a beautiful state that we want to protect but we also have energy. All of us want to strike the right balance."

The Power of Public Perception

At the heart of the controversy lies a great misconception about hydraulic fracturing. Many point to a 2010 film called "Gasland," which has circled the globe numerous times depicting a Colorado rancher lighting water on fire as it flowed from his kitchen sink's tap.

Although it was later proven that the natural gas found in the tap water did not come from a gas well, the dangers of "fracking" left an indelible mark on the minds of many.

"There is a huge amount of misinformation going through the airways," said AAPG Honorary member Pete Stark, senior research director and adviser at IHS. "Unfortunately, it's the term 'fracking' that

has been used to convey all of the evils and problems of the oil and gas industry."

Stark noted that AAPG President Lee Krystinik cited a survey during his address at the Annual Convention and Exhibition in April that showed the majority of Americans polled said they were against "fracking" but supported "hydraulic fracturing." This underscores the fact that many people don't understand what hydraulic fracturing is or how it might impact the environment, Stark said.

Often speaking to friends and family about her work as a petroleum geologist, Campbell explained, "I believe that most people don't understand how we get oil out of the ground. They are fearful of hydraulic fracturing because of these terrible news stories about groundwater contamination that simply aren't true."

Is 'Frac' Really a Four-Letter Word?

Industry and government websites galore explain that hydraulic fracturing – which typically lasts just three to five days during the development process – has been performed safely more than 1.2 million times in the United States since 1947.

More than 90 percent of oil and gas wells undergo hydraulic fracturing at some point, according to statistics from Coloradoans for Responsible Energy Development (CRED). Furthermore, neither the Environmental Protection Agency nor the COGCC has "ever" found a connection to chemicals entering the state's groundwater as a result of the widely used technique, according to CRED.

Oil and gas development generally affects relatively small areas averaging roughly two acres per well, and compared to other forms of land use, such as rural residential development, oil and gas development is relatively benign in its impact to wildlife and agriculture, reports the COGCC.

The fact that hydraulic fracturing is characterized as dangerous by anti-oil and gas spokespersons and as controversial in general press coverage has triggered a two-pronged opposition to fracturing and drilling in Colorado, Stark said. He underscored that only a small amount of drilling acreage in the Niobrara Shale impinges upon urban areas.

"It's not a statewide problem," he said.

Ironically, much of the opposition to hydraulic fracturing is occurring in Boulder, Colo., the location of the state's first oil well that produced for more than 100 years. While many residents may say they are opposed to fracing and drilling, some in



CAMPBELL



STARK



RAY



ROBINSON



Photos courtesy of Anadarko Petroleum

The Niobrara Shale in Colorado's Wattenberg gas field (DJ Basin) often is compared to the Bakken Shale. New technology is bringing new success stories in tight oil plays.

See Challenges, page 8

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Challenges from page 6

the industry speculate that they are actually opposed to traffic from tanker trucks, gravel trucks, flatbeds and dump trucks, water disposal issues, the laying of pipelines and setback regulations.

Cascading Consequences

If drilling were to completely cease in Colorado, it would be an understatement to say the state's economy would take a nosedive. A state-wide drilling ban – if one ever occurred – would undermine Colorado's hugely important economic recovery, which has been driven by the surge in oil and gas production from the Niobrara formation.

Approximately 110,000 jobs in the state are supported by the energy industry as well, according to COGA. Niobrara oil production more than doubled from 2009 through 2013 and was a major contributor to the \$1.8 billion increase in the 2013 Colorado General Fund, Stark said. Some wells in the Niobrara Shale – particularly in Weld County – produce more than 800 barrels of oil a day.

In addition, with the state's surplus of natural gas, it can rely less on coal for cleaner energy.

"The overall benefit for the state is just phenomenal," Stark said.

Colorado plays an important part in the nation's domestic energy supply as well, exporting natural gas through the 1,697-mile Rockies Express Pipeline all the way to Ohio.

Like other states that are finally able to tap into their unconventional resources, Colorado joins Texas and North Dakota in helping the United States achieve greater energy security. If technology such as hydraulic fracturing were banned nationwide, every citizen would feel it with natural gas bills two to three times higher than they are today, Stark said.

On a national level, the unconventional oil and gas industry supports nearly two million jobs and roughly \$62 billion in annual federal, state and local tax receipts, Stark said. It also has paved the way for a renaissance in manufacturing as a result of the liquids produced from natural gas. More than \$120 million is targeted for investment in U.S. chemical, plastics and energy intensive manufacturing plants, Stark said.

A May 2014 report released by Bloomberg announced that new technology – namely horizontal drilling and multi-stage hydraulic fracturing – has allowed the United States to surpass Saudi Arabia and Russia as the world's largest producer of oil and natural gas, based on estimates by the U.S. Energy Information Administration.

If the United States were to ban hydraulic fracturing, most of the forecasted \$5.1 billion in capital expenditures for unconventional oil and gas development through 2035 would disappear, Stark said. Without the continuing growth of U.S. unconventional oil, global supplies would tighten and gasoline prices might soon revisit the \$5 per gallon levels last seen during 2009, he said.

"Supply and demand and the shale revolution are changing the whole energy dynamic in the United States," said AAPG member John Robinson, geologist and owner of North Ranch Resources in Denver. "We spend a billion dollars a day buying oil overseas from OPEC. Many countries that are members don't like us. If OPEC decided not to send us oil, our economy would be devastated."



An Anadarko drilling rig in the Greater Natural Buttes area of the Uinta Basin

Industry Speaks Up

As November ticks closer, oil and gas companies in Colorado are taking on an aggressive public relations campaign to inform the public about the need for fossil fuels, the advantages of an energy independent nation, the myths and facts about hydraulic fracturing, and the strict regulations that protect the state that boasts an enviable quality of life.

"Our industry needs to be held accountable for fixing its negative image, which is not something the industry has been readily willing to do. If the public asks questions, we need to take efforts to respond," Campbell said, echoing the critiques of many that industry has indeed been slow to respond. "We need to help public perception instead of ignoring it."

Noble Energy and Anadarko Petroleum created CRED with one simple mission: to "get the facts on fracking first before you make a decision."

"Even though the oil and natural gas industry has utilized fracking safely for over 60 years, most Coloradans admit to not knowing or understanding what it involves. We're here to change that," reads the CRED website.

On the site are relatable answers to questions such as "Is fracking safe?" and "Where does fracking occur?"

In addition, more than 480 energy-related companies have joined the Western Energy Alliance, a nonprofit trade association engaged in all aspects of environmentally responsible exploration and production of oil and natural gas in the West.

"Anyone who will listen to us we will talk

to," said Kathleen Sgamma, vice president of Government and Public Affairs. "The industry has woken up and is trying to empower its employees to talk to friends and neighbors about what we do."

Sgamma reminds the public that the energy industry has been in the state since the early 1900s. In fact, the site reclaimed from Boulder's first well gives the city some of its open space – demonstrating that land bounces back even before modern reclamation requirements, such as reseeding and replanting.

While oil production is increasing in Colorado, the number of wells is declining. One horizontal well can replace eight to 10 vertical wells, and some companies are getting up to 60 wells per one well pad, Sgamma said. In other words, the industry is able to produce more oil and gas while reducing its footprint.

"One thing that gets lost is how much our modern lifestyle depends on oil and gas. People don't realize that the reality is there is no alternative that is viable for mobility, for transportation. A major part of our electricity comes from natural gas. You can't put in hundreds of wind turbines and then the gas goes away. Renewable energy is intermittent, and gas is a back-up," Sgamma said.

Carbon-based resources are used to make a plethora of plastics, chemicals, operating room equipment and pharmaceuticals – all of which are essential to the operation of homes, hospitals and more, she reminded.

"When we think of all that oil and gas does to keep people safe and warm – it gets them to work, it powers their

computers, their iPads, iPods – everything our modern society enjoys is fundamentally based in oil and gas," Sgamma said.

Flanders noted that Colorado is the first state in the nation to adopt methane regulations as well as require a hydraulic fracturing disclosure and baseline water testing. Setbacks have been increased from 350 feet to 1,000 feet.

"We have regulations from the minute you get a permit to the minute you reclaim that final bit of land," he said. "We are stepping up and not only achieving those regulations but exceeding those regulations many times."

In fact, some companies in the industry have helped draft stricter emission regulations.

"The reason we can work with the state so well is because the operators are willing to have those kinds of challenges," Flanders said.

Plays and Players

Colorado came back on the oil and gas map in 2008 when EOG Resources Inc. made a discovery in the North Park Basin, situated in north Colorado between the DJ Basin and Green River Basin in the northeast part of the state, according to online reports.

Often compared to the Bakken Basin, the Niobrara Shale in Colorado's DJ Basin, which includes the Wattenberg Gas Field, is the "King Kong" of plays at the moment, Stark said. Initially using new technology to extract natural gas, operators learned that that same technology can recover tight oil in the same shale deposits.

Current operators there include Anadarko, Noble, EOG, Chesapeake Energy, Whiting Petroleum, Quicksilver Resources, MDU Resources and Bill Barrett Corp.

Other areas attracting exploration and development include the Piceance Basin on the state's Western Slope, which contains the thickest and richest oil shale deposits in the world, according to some.

It is currently being developed by WPX. The Green River formation, which juts into Utah and Wyoming, is said to carry the largest deposit of oil shale in the world.

Fine the Way It Is

As the plays attract more players, communities are finding two things: Cities are growing into areas where oil and gas development is taking place and oil and gas development is growing into areas of urban development, Robinson said.

In Colorado, ballot initiatives will not be disclosed until Aug. 4, ensuring that "fracing wars" will endure for at least another two months. As newsrooms stock up on energy reporters, Coloradoans no doubt will get their fill – if they haven't already – of the issues at hand.

The state has long been a center for energy education for geologists, geophysicists and engineers, Ray said, referring to the Colorado School of Mines and the University of Colorado whose graduates take their expertise all over the world.

"It's interesting that this energy debate should come together here. My hope is that the scientific community will speak out about the facts and the public will have a balanced perspective when they go to vote," he said.

What hasn't been touted in the media are the quiet discussions successfully taking place between operators and local communities, Stark pointed out.

"Several negotiations have resulted

See Colorado, page 12

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Clash of the titans

Hickenlooper Working to Bridge the Gap

By DAVID BROWN, EXPLORER Correspondent

When Colorado Gov. John Hickenlooper (former AAPG member) set his sights on new air quality rules for the oil and gas industry, he called together some of the state's biggest producers and one of the country's biggest environmental organizations.

"For the first couple of months they sat down and focused on agreeing to the same set of facts," Hickenlooper told the EXPLORER. "Both sides got cranky from time to time. My job was to make sure both sides stayed in the room."

The result was a set of fugitive-emission rules and a leak-detection-and-repair regimen that could become a model for other states, and is now considered the strongest in the United States.

Discussion in that rulemaking process included Anadarko Petroleum Corp., Encana Corp. and Noble Energy Inc., and representation from the Environmental Defense Fund, a green advocacy group with a special interest in air quality.

"There's been such bad blood for a while, there was a level of mistrust that we had to work through," Hickenlooper said.

The oil and gas industry is keeping an intense watch on the development of state regulations that affect hydraulic fracturing. The regulatory picture still isn't completely clear, but it is becoming clearer.

Operators in some states have worked with regulatory agencies, environmentalists and citizen groups to devise new rules for hydraulic fracturing. In each case, a primary



HICKENLOOPER

"If we do a good enough job, people will calm down about the perceived risks of hydraulic fracturing. What this is, is a process of winning back the public trust."

goal of the industry was to lessen public concerns.

Some recent developments:

► New water-testing rules took effect in Wyoming earlier this year.

Companies now must test wells and springs within a half-mile of a drilling site, both before and after drilling. Testing targets the presence of several chemical compounds, dissolved gases, bacteria and other factors.

► The Colorado air quality rules, finalized in February, require 95 percent capture of methane and volatile organic compounds from specified industry operations, including new and recompleted wells, centrifugal compressors, dehydrators and storage tanks. Some tanks are subject to even stricter limits.

► Baker Hughes Inc. published a Chemical Disclosure Policy for hydraulic fracturing, aimed at full disclosure of

chemicals used in the fracturing process.

"Baker Hughes believes it is possible to disclose 100 percent of the chemical ingredients we use in hydraulic fracturing fluids without compromising our formulations – a balance that increases public trust while encouraging commercial innovation.

"Where accepted by our customers and relevant governmental authorities, Baker Hughes is implementing a new format that achieves this goal, providing complete lists of the products and chemical ingredients used," the policy states.

Hickenlooper began his career as a petroleum geologist in the 1980s and later opened a restaurant and brewpub in Denver, then was elected mayor of Denver in 2003 and governor of Colorado in 2010.

He emphasized the importance of states bringing all stakeholders together in creating oil and gas rules on which the public can rely.

"If we do a good enough job, people

will calm down about the perceived risks of hydraulic fracturing," he said. "What this is, is a process of winning back the public trust."

The Costs of Compliance

After Colorado adopted the new air quality regulations, some operating companies complained about the potential cost of compliance.

The Colorado Oil & Gas Association issued a brief statement from Doug Flanders, COGA director of policy and external affairs in Denver: "The new rules accomplish much, which we support. Unfortunately, we were not successful in ensuring that the rule accommodates the differences in basins and operators," the statement said in part.

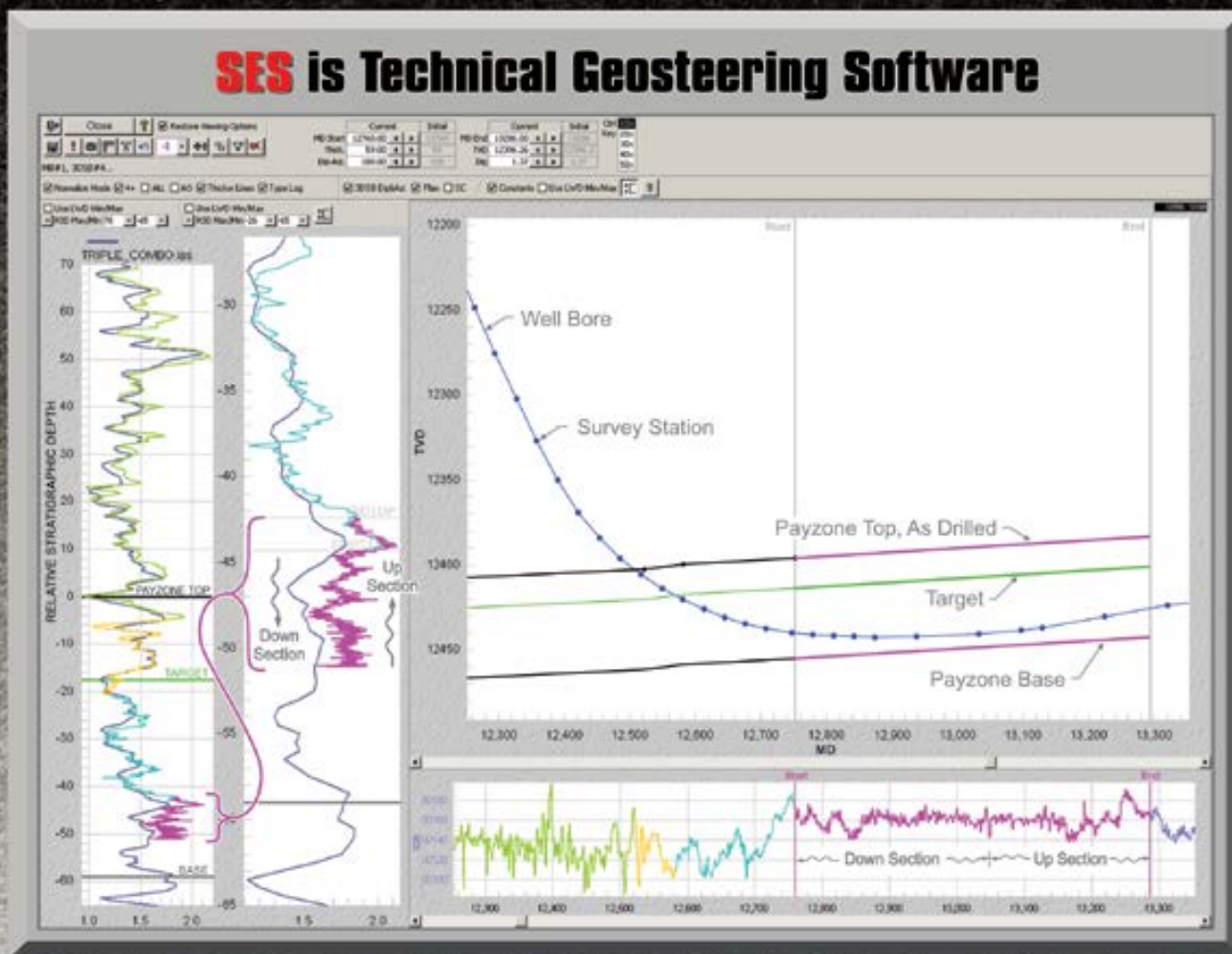
Flanders said the emissions-capture and leak-detection regulations are just the latest items in a long process of rulemaking that affects the oil and gas industry in Colorado, most of it from the Colorado Oil and Gas Conservation Commission.

"Since 2008, we've essentially been in perpetual rulemaking," he said. "We've had so many changes it's kind of hard to tell how well the process is working. We have good relations with the commissioners. We have good relations with the Commission."

He noted the regulations do not directly address hydraulic fracturing but are broader

See Hickenlooper, page 12

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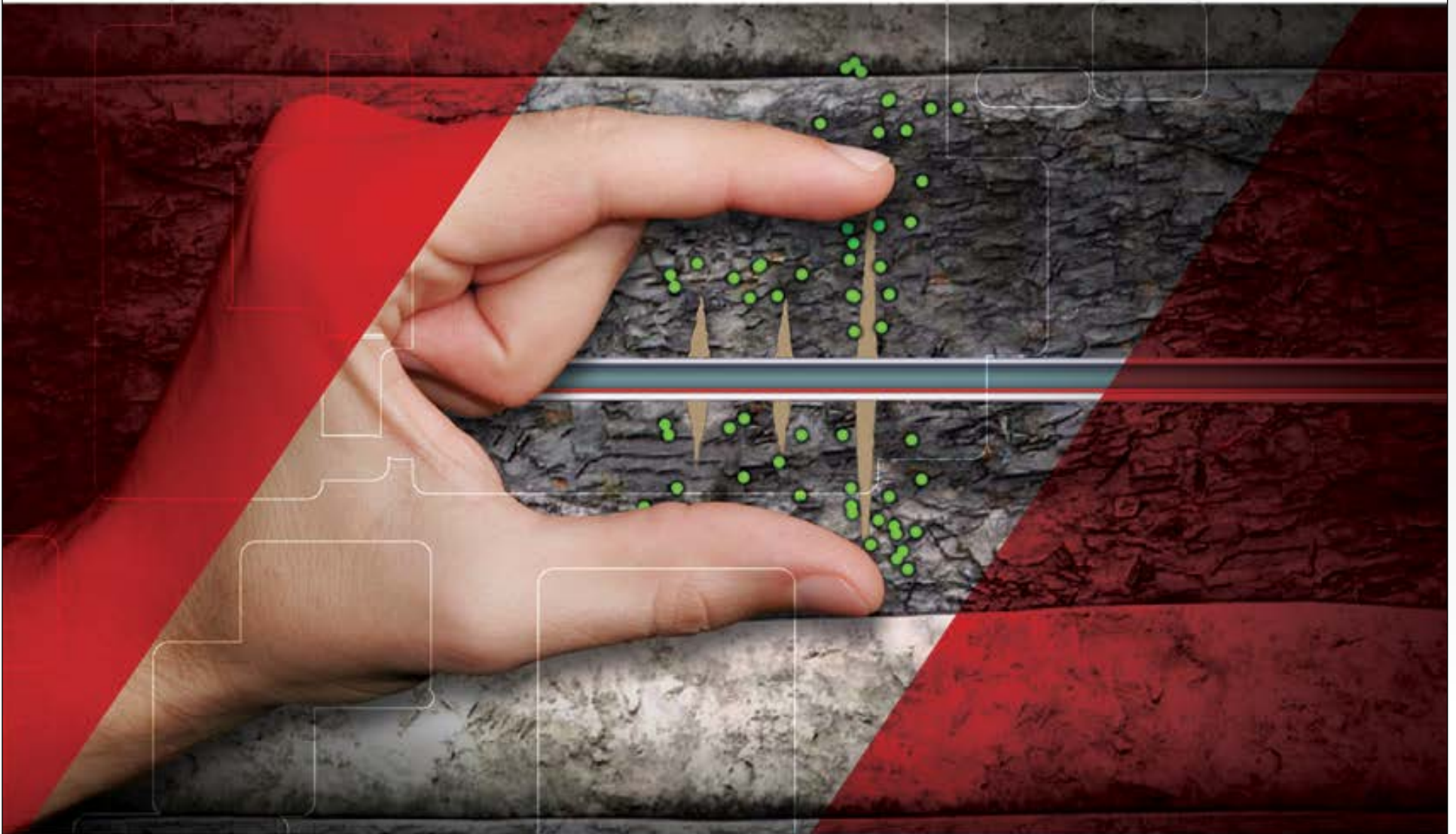
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Colorado
from page 8

in agreements with local communities on issues such as the setback of well locations from buildings that can be regulated by the COGCC. These have been going on underneath the media radar screen and it has allowed projects to move forward without a contentious ballot referendum," he said.

What Colorado has been doing for the past 100 years is working, Flanders said. While the state has authority to regulate all downhole and "inside the fence" activities, local communities have the power to govern transportation and emergency response, and work with the state on issues regarding noise and lighting. The way the government

is structured, the state and local communities must negotiate at the same table already, he said.

"People move to Colorado because it's pristine, but oil and gas have been here for more than 100 years. People argue that they want a pristine state, but it's already there – even with industry going on all this time," Flanders said. "While we are 'in an oil or gas boom,' we really are not. We have fewer wells with more production. The well count is going down because we are more efficient. We leave less of a footprint and we are more pristine."

When asked how he thought the November vote on the ballot initiatives might go, Ray refrained from guessing: "I believe that scientific truth – once it is explained and understood – always helps people make the right decisions." ■

Hickenlooper
from page 10

rules targeting industry activities. They "are not 'hydraulic fracturing' per se – they are oil and gas rules," he said.

Colorado has emerged as a national leader in regulations affecting hydrofracturing, but at the same time has had to significantly increase regulatory staff, according to Flanders.

"Some of the things that other states are still grappling with we dealt with in the 2008 rulemaking, early on," he said. "I think what you're seeing (in Colorado) is a process that's working, but you're also seeing a process that's stressed."

Andrew Casper, COGA's regulatory counsel, said the need to add additional employees and to increase spending to

comply with the state's new oil and gas rules do put a meaningful burden on the industry.

"Operators are constantly working to implement all the new regulations," he noted. "It's an ongoing process."

A Work in Progress

The Environmental Defense Fund supports a variety of green initiatives but has focused many of its efforts on issues related to air quality, said Dan Grossman, Rocky Mountain regional director for EDF in Boulder, Colo.

He supports the state's recently developed emissions-capture and leak-repair regulations and hopes they become a model for other states. Overall, he gives mixed grades to Colorado's regulatory approach to oil and gas.

"I think it's safe to say that it's been a mixed bag. The agencies have gotten some things close to right, and some things not so close to right," Grossman said.

While Colorado has now promulgated strict air quality rules – and Hickenlooper himself prescribed a "zero tolerance" policy on methane emissions – Grossman described regulation as an ongoing process.

"These rules addressed production but not so much compression, distribution and transmission," he said. "It makes sense for us to think about how we might realize efficiencies further downstream."

Technological advances, especially, could affect the development of future regulations, he said. As an example, he cited the possibility of better emissions-monitoring tools than today's typical infrared flare-gun monitoring.

"As that technology develops, we may need to take another look at the regulations," he said.

EDF works with corporations on environmental matters because it wants "to make real progress, and not just rhetorical points," Grossman said. He acknowledged that companies, environmentalists and special-interest citizens groups have had problems cooperating in the past.

"We set out to disprove that theory in Colorado, at least in regard to the air rules," Grossman observed. "But a lot of that burden falls on industry."

Today, cooperation seems more possible, even likely. A desire to ease public concerns about the possible adverse effects of hydraulic fracturing brings industry to the negotiating table.

Both Hickenlooper and Grossman mentioned a "social license to operate" – the concept that corporations can conduct operations only with society's support and approval, which is neither automatic nor unconditional.

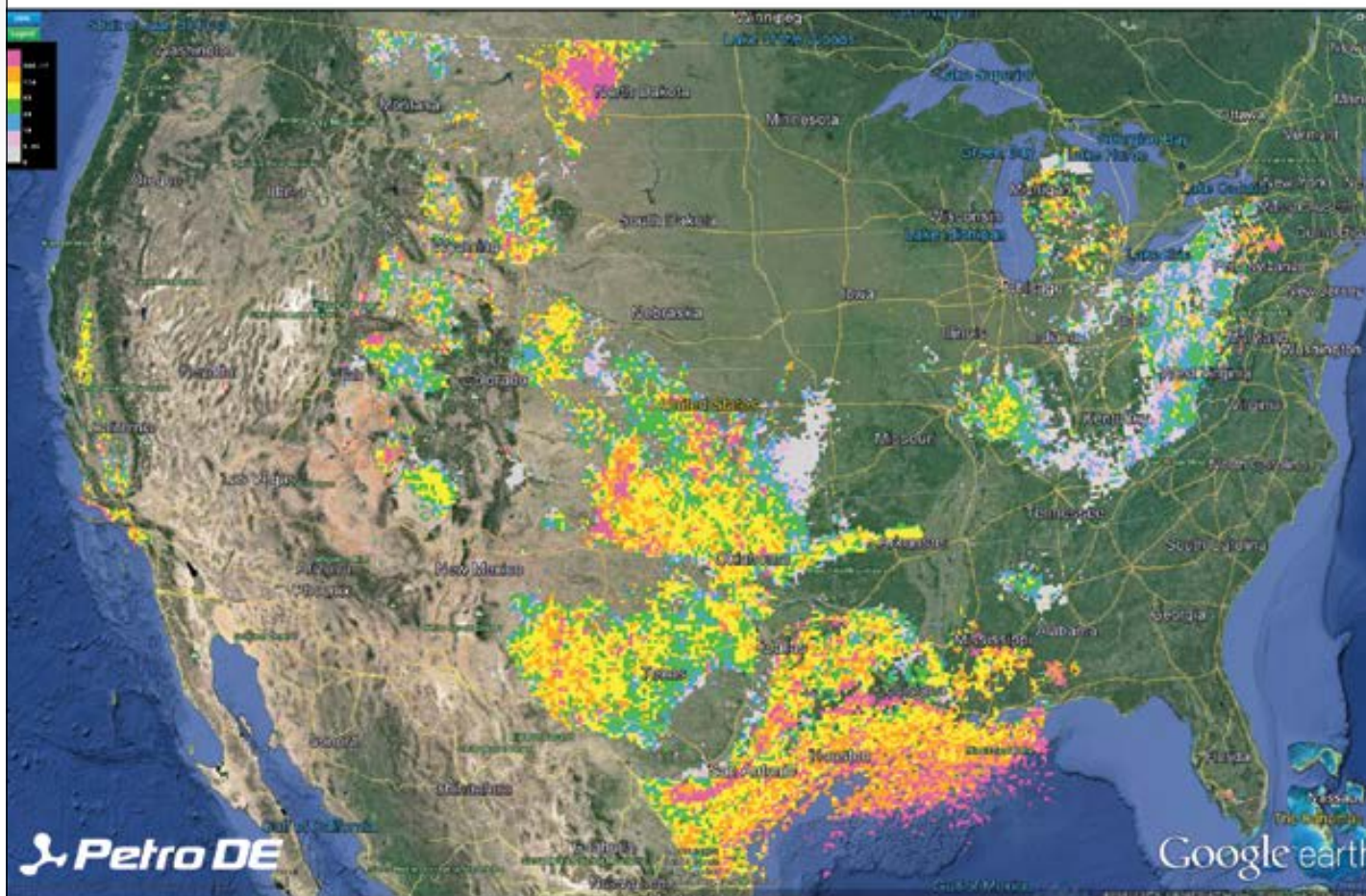
Environmental groups come to the table to have a voice in the regulatory process, and because they recognize that hydraulic fracturing isn't going to go away. Some, like Grossman, believe that natural gas can replace or offset more-polluting fuel use.

"This incredible energy boom brings enormous opportunity for the country and the environment, but also enormous risks," he said.

Hickenlooper said increased oil and gas production from hydraulic fracturing is providing huge benefits for the United States, while also taking industry operations "right to the front doorsteps of people in suburban communities" who had never even expected to see a drilling rig or well.

"I think it's one of the great opportunities for this country," he said. "It's also bringing very rapid change. The industry needs to stay out ahead of the change." ■

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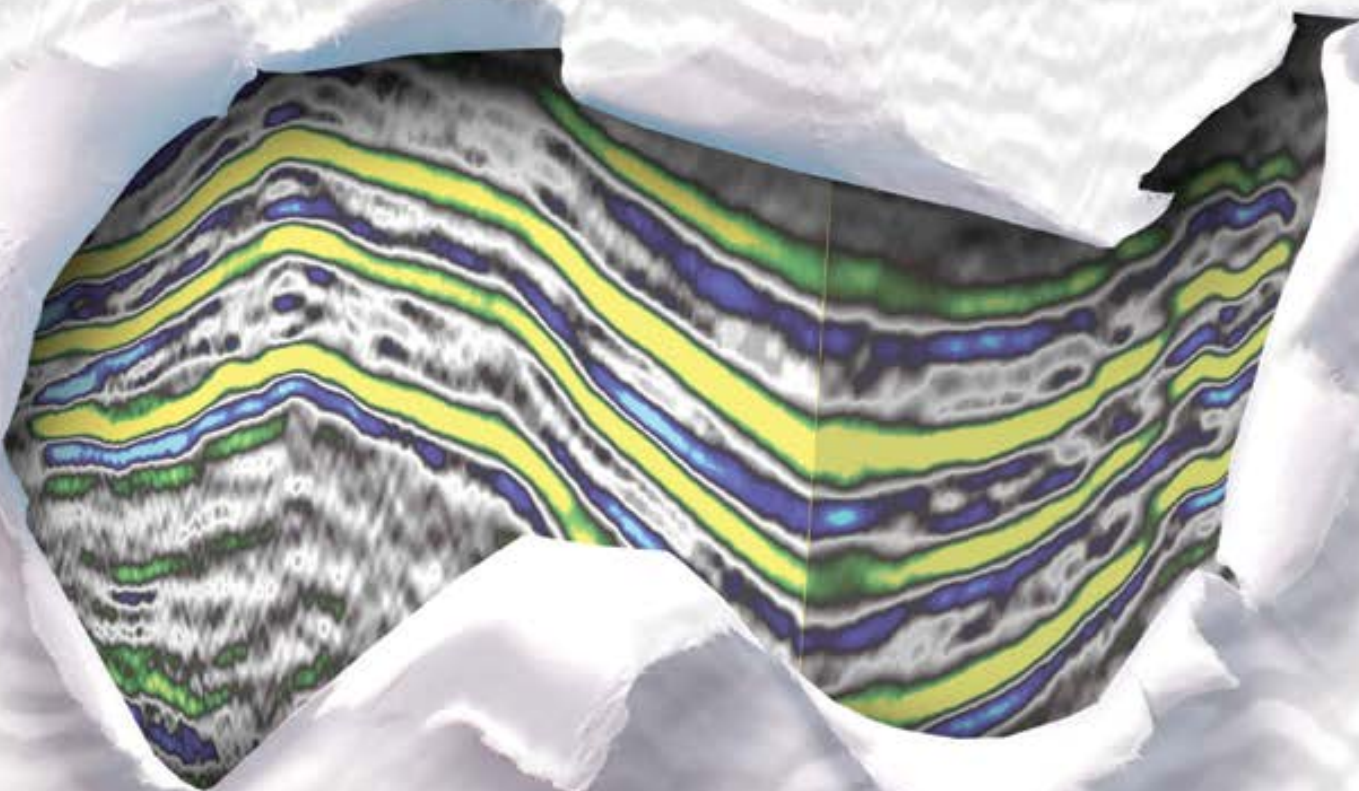
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Bakken Boom Brings Big Changes to Dakota

By HEATHER SAUCIER, EXPLORER Correspondent

Prior to the 2008 oil boom in the Bakken formation, the state of North Dakota had its share of problems.

It was losing an average of 5,000 residents each year to places that could offer young college graduates jobs other than farming and teaching. As a result, births from young families in the state declined and the population began to age, explained Kevin Iverson, manager of the North Dakota Census Office.

In 2001, the state lost approximately 6,000 people, forcing conversations about consolidating schools and ways to keep rural towns alive.

"We don't have discussions like that anymore," Iverson said.

Since the Bakken Boom hit the state with gusto roughly six years ago, it is as if the history of North Dakota is being played in reverse. Thousands of people from all over the country are crossing the state's borders in an unprecedented ingress to work in one of North America's largest tight oil plays and reap the benefits of the area's most profitable oil boom.

In 2013, approximately 18,000 people moved to North Dakota. The year before, roughly 13,000 people came. The year before that, 6,900 people made the journey to the state dotted by small towns, small lakes and mountains.

Today, the state's population is at an all-time high at 723,000, putting forth a new set of challenges that include a desperate need for housing, new schools and updated infrastructure, Iverson said.



Once it was a sparsely populated region. That was then. This is now – the Bakken shale has brought big changes, good and bad, to North Dakota.

You won't hear many North Dakotans complaining, however. Most continue to reel from the historical amounts of oil being pumped from the earth that shifted their growing economy into overdrive. The pace of their economy's growth outranked all other states in 2012, according to the U.S. Bureau of Economic Analysis.

Humble Beginnings

The 200,000-square-mile Bakken formation, which lies in the Williston Basin, is located in North Dakota, Montana and Canada.

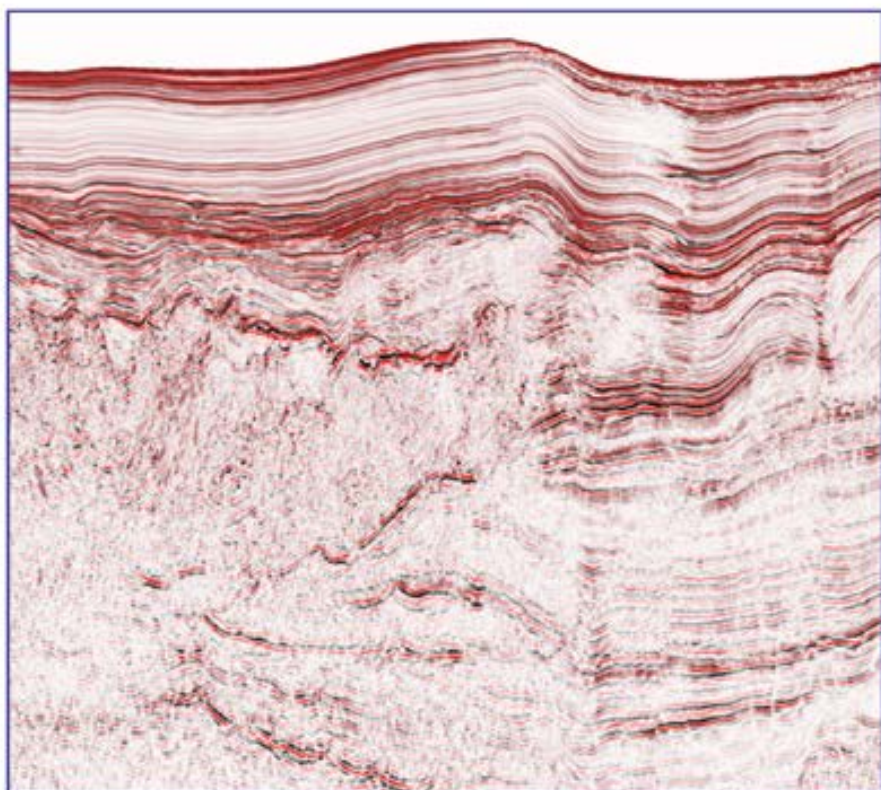
It was named after a Tioga, N.D., farmer who owned land where the formation was first discovered. In 1951, the first oil well in the Bakken produced more than

26,000 barrels that year, and other wells soon followed suit. But the limitations of mid-century technology prevented the extraction of an estimated 7.4 billion barrels of recoverable oil, according to the U.S. Geological Survey.

In the 1980s a second oil boom occurred, delivering more than 50 million

[See Bakken, page 16](#)

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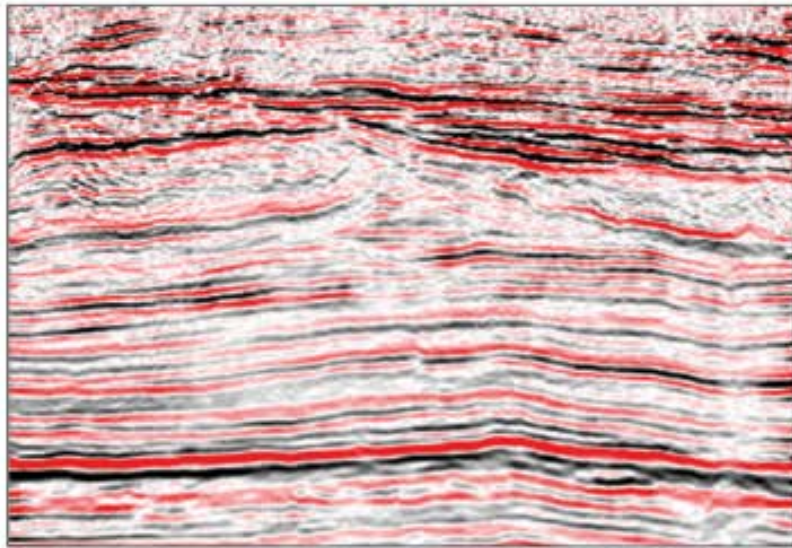
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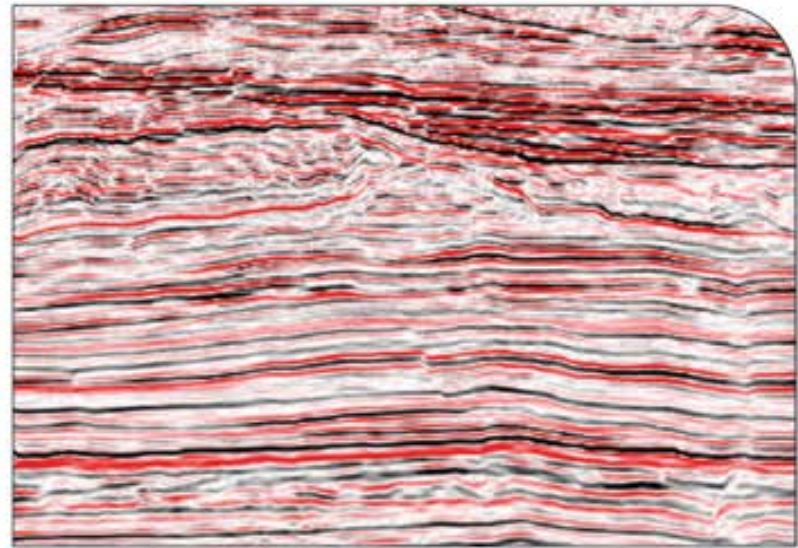
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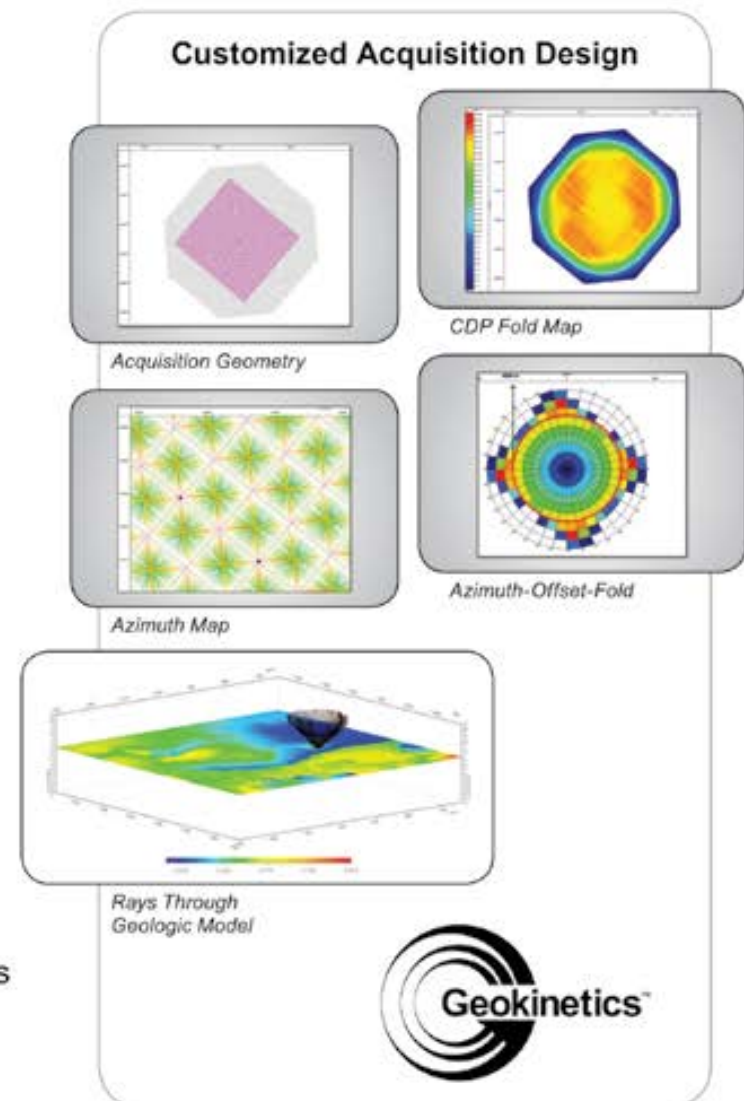


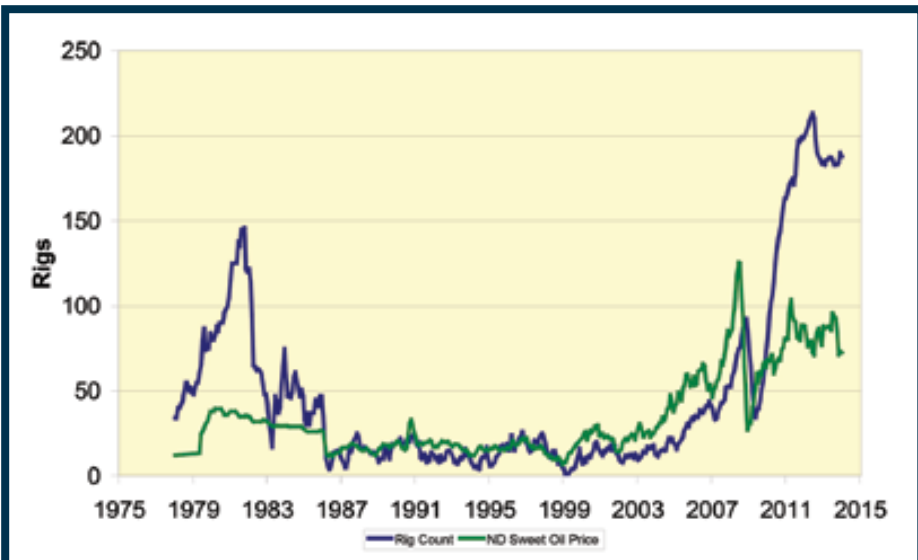
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Business is booming in the Bakken: North Dakota average monthly rig count. Graphic courtesy of North Dakota Oil and Gas Division.

Bakken from page 14

barrels of oil annually for several years before annual totals settled in the 30 million range.

However, when modern technology was brought into North Dakota from the Barnett formation in the Fort Worth Basin, it was as if the code to a safe was deciphered. The door opened for small farm towns such as Stanley, Watford City, Ray, Tioga, Parshall, Alexander and Williston – the town some say is closest to the heart of the Bakken Boom.

“Clearly, this cycle that we are in is the most important cycle the Williston Basin has ever seen as a result of horizontal drilling and multi-stage hydraulic fracturing,” said AAPG Honorary member Steve Sonnenberg, professor and Charles

Boettcher Distinguished Chair in petroleum geology at the Colorado School of Mines and past AAPG president. “If it were not for that combined technology, much of the Bakken would be uneconomical to produce.”

Using horizontal drilling and multi-stage hydraulic fracturing in tandem worked well in the Barnett shale, where natural gas was plentiful. But some in the industry questioned whether the technology would work on larger, tight oil molecules, Sonnenberg said.

They received their answer in the Bakken.

And Then, Boom

As of February of this year, 951,000 barrels of oil are produced daily in the Bakken, said Tessa Sandstrom, a spokesperson for the North Dakota Petroleum Council (NDPC). The Bakken has enabled North Dakota to become the second largest producing state in the country, with its top producing counties being Mountrail, McKenzie, Dunn, Williams and Divide.

Today, the state has 10,186 producing wells, 7,000 of which are unconventional, Sandstrom said.

The state’s economy is outpacing all other states – growing at 13.4 percent, three times as fast as Texas and five times as fast as the national average of 2.5 percent, said Jesse Bradley of the North Dakota Department of Commerce. The growth is attributed to economic production, new jobs and increasing export sales, he said.

The Bakken play “keeps getting better and better,” Sonnenberg said, noting that some operators are beginning to drill in the upper and middle Three Forks formations located beneath the Bakken shale.

And with a \$30.4 billion impact on the state, the petroleum industry is changing the face of North Dakota:

- ▶ Its population is burgeoning and becoming younger.
- ▶ Entrepreneurs are opening up restaurants and other businesses to serve the masses.
- ▶ Small farm towns are turning industrial.
- ▶ New schools and recreation centers are being built.
- ▶ Old farm-to-market roads are being repaved and given signage for the first time.
- ▶ Single-family homes and apartments cannot be constructed quickly enough.

Growing Pains

“Our biggest struggle, even in the early 2000s, was how do we get young people to move back and stop the decline of rural communities?” Sandstrom said. “And now we are asking, ‘How do we accommodate this enormous growth?’”

Finding housing to accommodate the tens of thousands of oil patch workers, their families and others who flock to state in hopes of jobs and better incomes continues to be a priority, Iverson said.

The average rent for a one-bedroom apartment in Williston is higher than in Los Angeles and New York, according to a recent survey from Apartment Guide, which quotes the average rent for a 700 square-foot, one-bedroom apartment in Williston at \$2,394. (New York’s average is \$1,504.)

While thousands of single family homes and apartment units have been constructed, some people continue to live in overpriced hotels, in temporary housing provided by operators – sometimes called “man camps” – and some may even sleep in their trucks. Many are hesitant to move their families

See **Boom Times**, page 18

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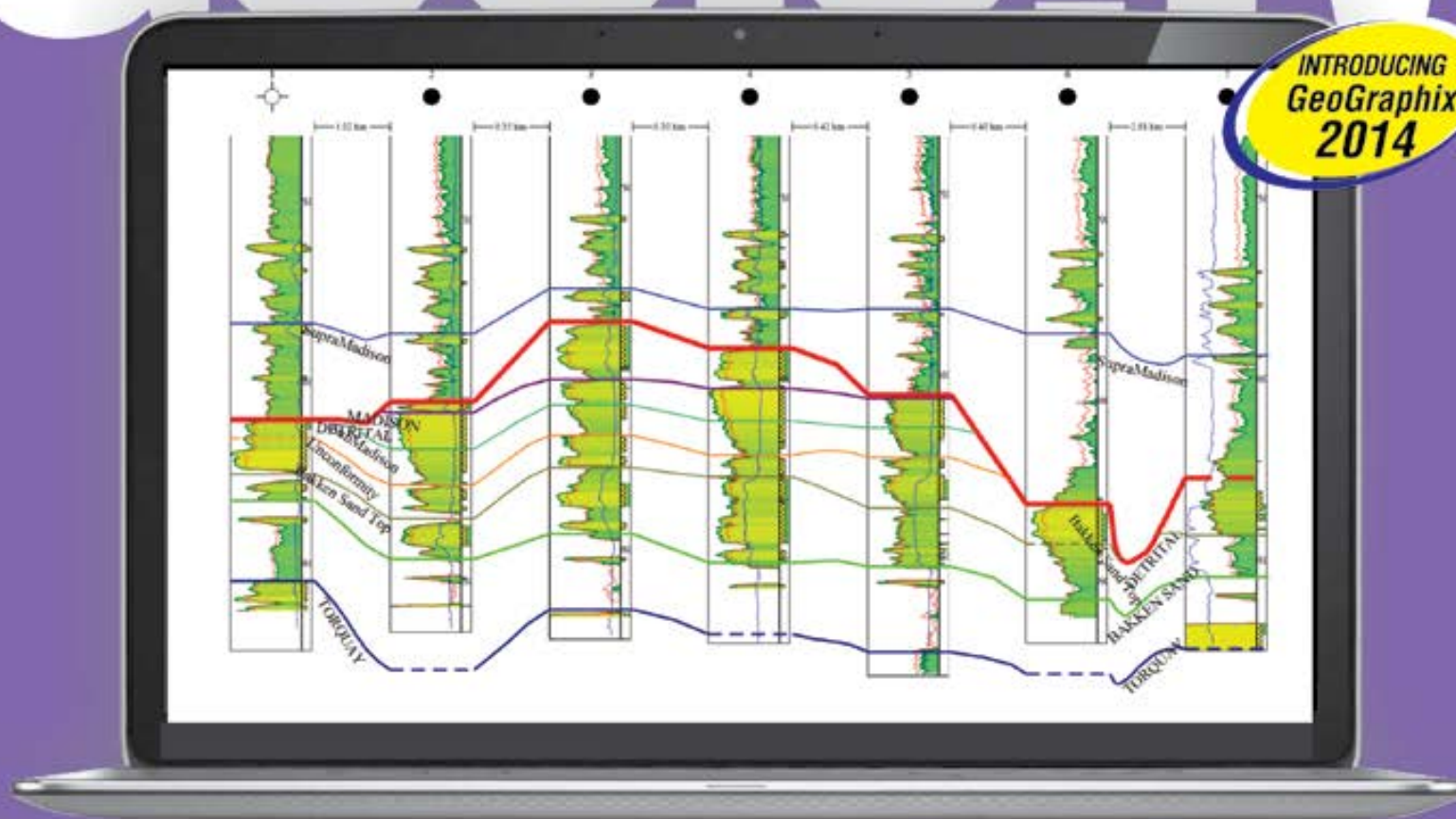
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Boom Times from page 16

to North Dakota because of the lack of affordable housing, Iverson explained.

In this rural part of the state, constructing housing becomes more challenging without the proper infrastructure, Iverson explained.

"You need to increase the power supply, build water mains, build roads, and you need workers to build those things," he said. "Everything has become constrained. It's not a matter of building a house anymore."

Before 2008, the state issued no more than 3,000 permits a year for single-family homes, Iverson said. Last year, more than 10,000 permits were issued.

To accommodate a spike in enrollment in public schools, North Dakota has or is currently building nearly 20 new schools, 12 additions to schools and more than 60

new classrooms since 2008, said Kristen Baesler, state superintendent of the North Dakota Department of Public Instruction. With increases of as much as 9,000 new students a year, "We are in portables and in every nook and cranny of our existing buildings," she said.

North Dakota is the only state in the nation that has recently increased funding for schools grades K-12, Baesler said.

What's more, schools are quickly moving into the landlord business, building duplexes and apartments for newly recruited teachers, she said.

The food service and hospitality industries are struggling as well, Iverson said. In a state where there are more job opportunities than people, it is difficult for restaurants, fast-food chains and general merchandise stores to attract and keep employees.

Iverson said a hotel adjacent to his office

is advertising sign-on bonuses of \$500 to \$1,000. A local Wal-Mart is offering \$12.20 an hour for the graveyard shift – most likely a job stocking shelves, he said.

Pro-Industry

Despite the challenges of an exploding population, the majority of North Dakotans embrace the industry's presence in the state.

An annual survey taken by the NDPC shows that for the past three years, roughly 80 percent of the population has held a favorable view of the oil and gas industry in North Dakota, Sandstrom said.

"People here have a good understanding of hydraulic fracturing and what the risks are and that we have environmental regulations in place to protect the environment," she said.

Prior to the boom, North Dakota's per

capita income was 86 percent compared to the rest of the country, Iverson said. Last year, it hit 128 percent – second only to Connecticut.

Industry also has created an estimated 60,000 jobs, 48,000 of which are direct, Sandstrom said. Job Service North Dakota reports 25,000 job openings as of April of this year – a 12 percent increase from the prior month and more than a 29 percent increase from April of last year.

"Anyone not working today in North Dakota – it's not because they can't, it's because they don't want to," Iverson said.

In addition to new schools and classrooms, North Dakota is using tax revenues created by the industry to build recreational facilities in towns such as Williston and Crosby, a town of little more than 1,200 people that recently opened an ice skating and hockey rink, Sandstrom said.

Watford City, another small town now bulging at the seams, is considering building a recreation center much like the \$80 million center that opened in Williston in March – with 2,500 people visiting on the first day.

Furthermore, unpaved and under-maintained roads, designed for grain trucks and tractors and limited traffic, are seeing improvements, said AAPG member Tofer Lewis, a geologist with Enerplus Resources. Many are being widened, repaved and outfitted with signage, as residents new to the state can't rely on the locals' familiar landmarks to find their way around.

The improvements will not only accommodate an increase in activity, they will add long-term enhancements that will benefit local communities, he said.

Importantly, the Bakken boom also is advancing scientists' understanding in the technology needed to extract unconventional resources, Lewis said. The first horizontal wells drilled just a few years ago were only a mile in lateral length and drilled from a single surface pad location. Now in the Williston Basin, long-laterals are approaching three miles in length, and multiple wells are being drilled from the same pad, which greatly decreases the surface disturbance and resources needed.

"By advancing our understanding the United States is becoming a leader in unconventional resources technologies," he added. "Other countries are now looking to us for assistance and advice on how to utilize their resources."


Embracing Diversity

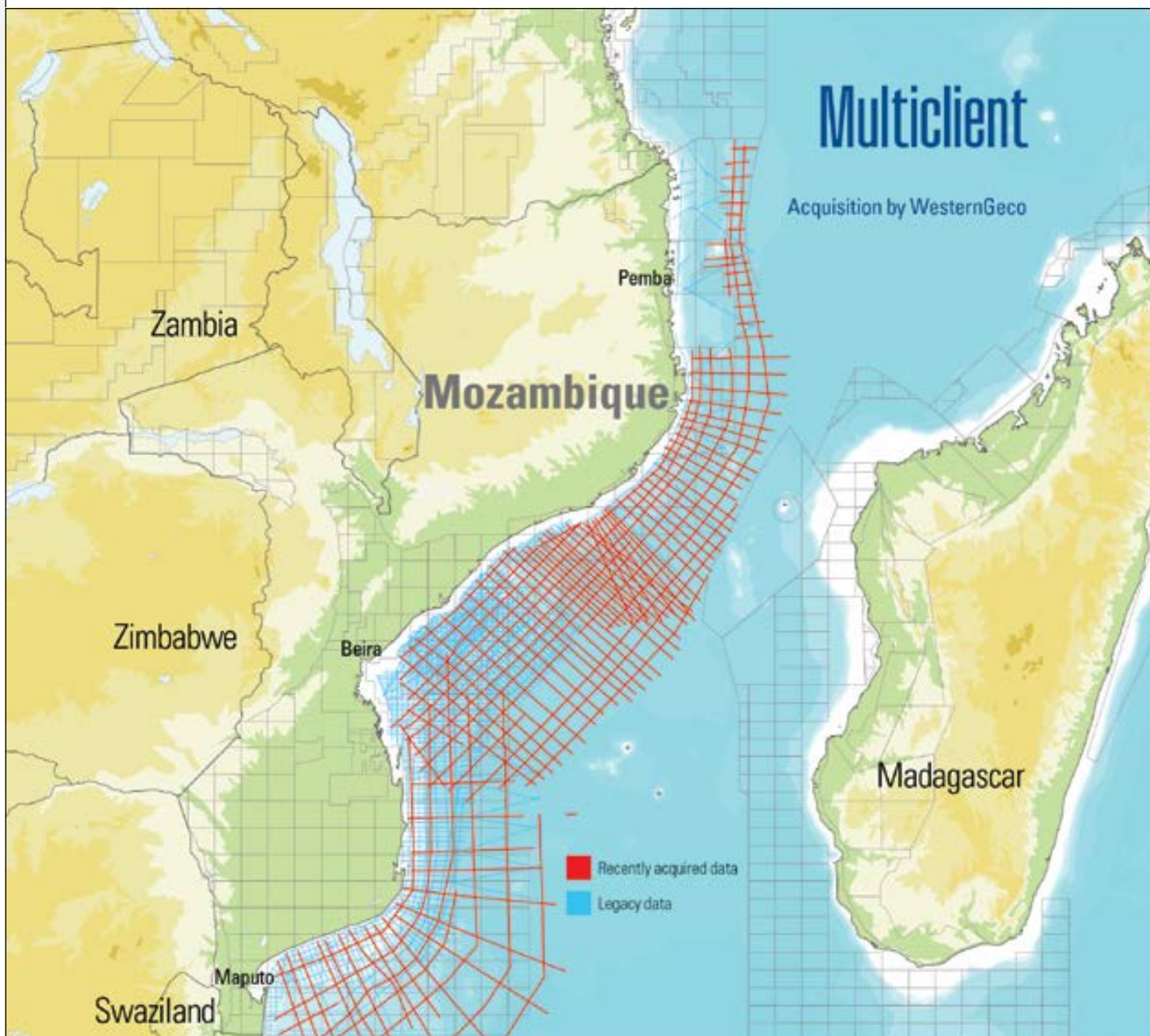
And for the first time in many years, North Dakotans are getting a taste of diversity.

"We've been homogenous for so long," Baesler said. In the schools, it wasn't uncommon for "Ms. Miller," for example, to have taught three generations of one family, she said. These days, to address the fact that her class contained students from 29 states, one teacher in Williston brought flags representing all the different states and asked students to share their backgrounds, Baesler said.

"Lesson plans have been adjusted to let the students learn about each other and create a bond among classmates," she added.

Despite grappling with an ever-increasing enrollment, North Dakota school districts seem to work well under stress. Quoting a recent Gallup poll, Baesler said North Dakota was rated No. 1 in the nation for parent satisfaction with the public education system.

"It's fantastic," Baesler said. "We pull ourselves up by the bootstraps and say, 'Let's get this done. We've got kids to take care of and oil to produce.'" 





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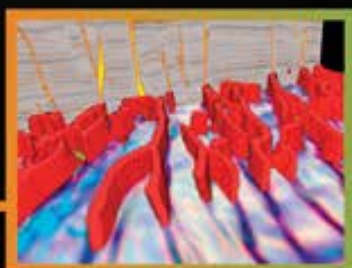
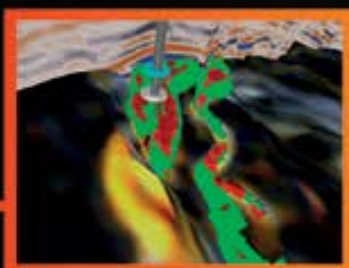
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UGS multi-year study continues

Cane Creek Shale Keeping Utah in Energy Mix

By LOUISE S. DURHAM, EXPLORER Correspondent

Industry interest and activity in shale reservoirs continues to escalate. The big headline-makers, such as the Barnett, Haynesville, Marcellus, comprise only some chapters of the big story. The less familiar names also are beginning to make their mark. Count the Cane Creek shale in the Pennsylvanian-age Paradox formation in the Paradox Basin in southeast Utah among those receiving considerable attention. "The Cane Creek is a transgressive-regressive sequence in the lower portion of the Paradox," said AAPG member Stephanie Carney, geologist at the Utah Geological Survey (UGS). "It's tens of feet to nearly 200 feet thick, over-and underlain by salt beds," Carney said. She noted that it's divided into the A, B and C intervals, in descending order: ▶ B interval is the primary hydrocarbon



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"This is where our study goes beyond studies done in the past. It's access to all of the new cores from wells drilled in the last couple of years."

source rock and productive zone, comprised of black organic-rich shale, dolomite, dolomitic sandstone and some anhydrite. Naturally occurring fractures are essential for economic production. ▶ A and C intervals are principally dolomite and anhydrite and act as seals for the B interval. "There's been activity in the Cane Creek since the 1960s, but just vertical wells with limited production," said AAPG member Mike Vanden Berg, senior geologist and petroleum section manager

at the UGS. "In the 1990s, operators started drilling horizontal wells but with short laterals, which hindered success. "Recently, they're drilling much longer laterals with much more success," Berg emphasized.

A Big Deal

The UGS is in the midst of implementing a multi-year study of the shale oil potential of the Cane Creek shale formation. The effort is being funded by

the U.S. Department of Energy. This is a big deal. The USGS recently assessed the undiscovered oil resource in the Cane Creek shale in the Paradox Basin at 103 MMb (95-percent confidence level) and 198 MMb (50-percent confidence level). Most of the operators and explorers in the play are small independents who are not in a position to conduct their own detailed basin-wide research, which is needed to truly understand the tight oil potential of this shale formation. Carney pinpointed the goals of the UGS study: ▶ Gain insight into the geological, geochemical and geomechanical rock properties of the Cane Creek shale. ▶ Further define the play and the reservoir characteristics. "The Big Flat field (near Moab) in the central portion of the play area is where

See Cane Creek, page 22

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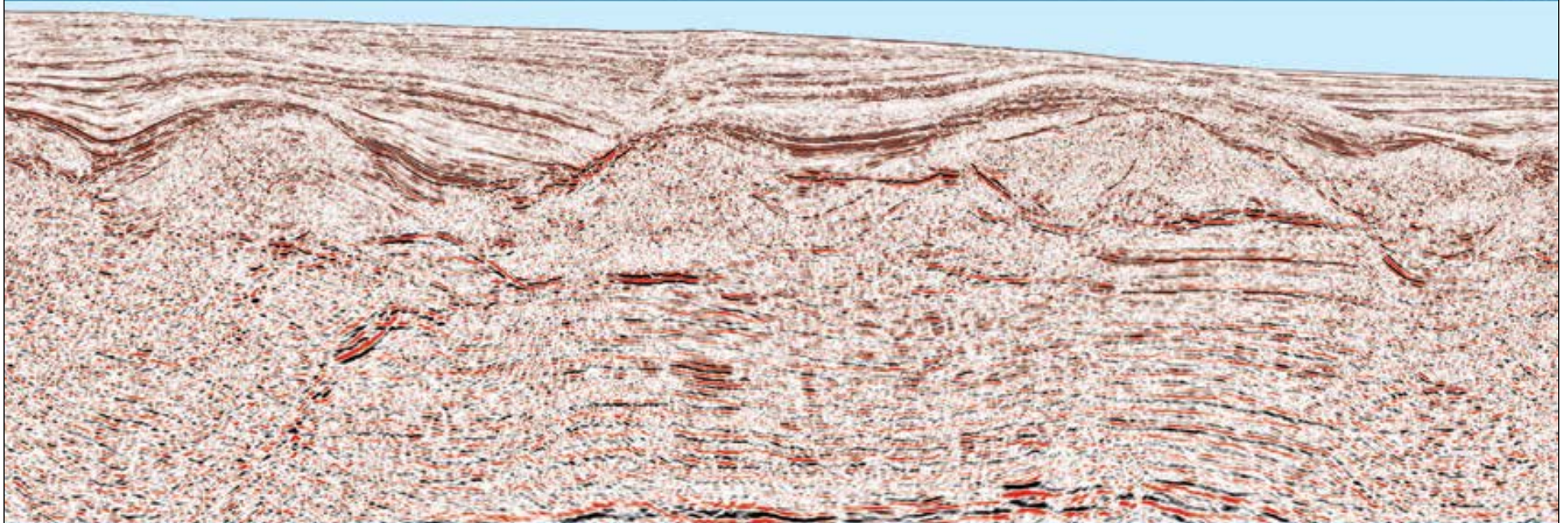
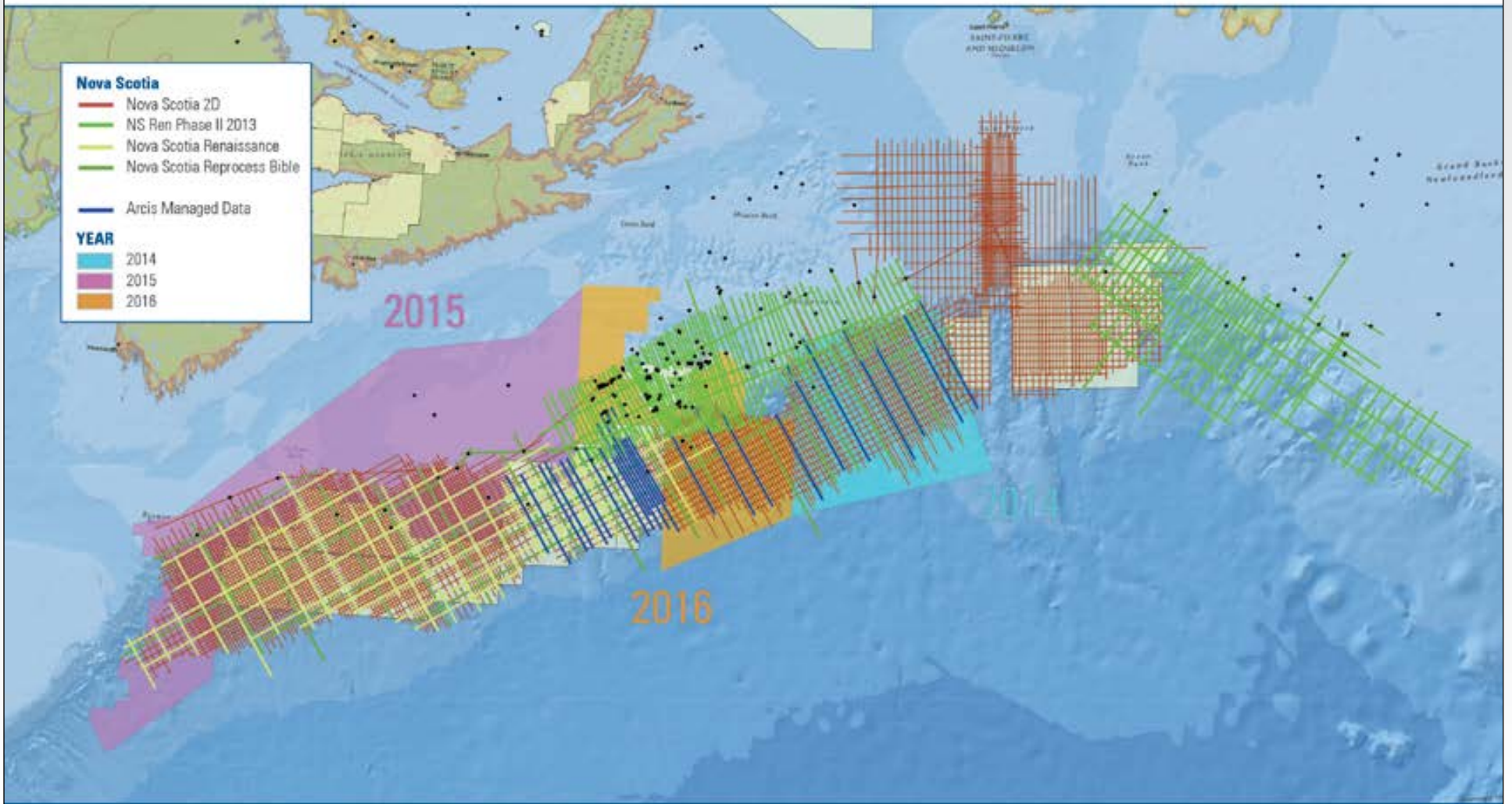
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Cane Creek from page 20

most of the current production is taking place,” Berg said. “We’re trying to determine what is the production potential to the north and south, where there’s been very limited drilling.

“We think there’s still potential (in these areas),” he emphasized. “The differences could be as simple as better structure in the Big Flat that has caused more fracturing.

“We do see that the thermal maturity changes from south to north,” he said. “The organic matter is still kind of in the early oil window, but in the central to north – it’s in the peak oil window.

“This may have something to do with why there’s pretty good production in the central portion.”

Looking for Fractures

Because they have cores from the south and the Big Flat field, they can see lithology and facies change between the two areas. Carney noted that this could contribute to the area productivity.

“This is where our study goes beyond studies done in the past,” Berg noted. “It’s access to all of the new cores from wells drilled in the last couple of years.

“We can map the three intervals using geophysical logs,” he said, “but the question has always been: Has the facies changed across the basin?

“It’s hard to tell from geophysical logs,” he said, “and that’s where the cores come in.”

Carney noted there is significant work yet to be done, including a more detailed look at the fractures.

“We’ll do fluid inclusion work on the fractures to figure out timing, whether the fractures occurred before or after oil migration,” she said. “We’ll look at more cores to do geomechanical work on a lot of the cores to help come up with strategies for well completions.”

The outcome of just one of the wells drilled by Fidelity E&P in 2010 in the Big Flat field makes a profound statement about the production that can be attained.

After the first year of production, no other well in the lower 48 states had produced as much as that one well, according to Jayne Gates, asset team manager for the Paradox Basin at Fidelity.

The Cane Creek 12-1 reportedly produced between 600,000 and 700,000 barrels of oil during its first year in operation. The oil continues to free-flow to the surface today, meaning it doesn’t yet require a pumping unit.

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Unconventional Targets Give San Juan New Life

By LOUISE S. DURHAM, EXPLORER Correspondent

The time-worn phrase “everything old is new again” is an apt description for much of the revved-up activity in the oil patch these days.

Old producing zones thought to have died long ago are being resuscitated via advanced technologies, including horizontal drilling and innovative seismic techniques.

New zones also are being tapped and produced successfully in a variety of approaches, including commingling production from a previously unproduced interval with that of a known producer.

And perhaps the best known “new again” region is the Permian Basin in west Texas, where activity is at a near-fevered pitch.

An active yet lower profile revitalization



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is under way in the San Juan Basin in the Four Corners area, which straddles the borders of New Mexico, Colorado, Arizona and Utah.

The renewed action is the result of completions in unconventional reservoirs

It's the more progressive technology being applied to previously bypassed pay zones that is driving today's success.

in the Cretaceous-age Mancos shale and Gallup sandstone formations, according to Sophie Berglund, senior geologist at WPX Energy.

WPX has been active in the basin for a number of years.

Berglund noted that legacy drilling and completion operations focused on conventional reservoirs in these formations for decades. Vertical drilling has achieved much successful production in the basin, but it's the more progressive technology being applied to previously bypassed pay zones that is driving success today.

The characteristics of the Mancos and Gallup can make drilling a challenge for the operators.

“The Mancos shale and Gallup sandstone reservoirs were deposited relative to the same shoreline in the Cretaceous Western Interior Seaway,” Berglund said. “But they differ in environment and reservoir characteristics.

“The San Juan is a big area, and there are some interesting changes in how the reservoir changes and the maturity of the source rock changes to make distinct plays,” she commented. “Serendipitously, Mancos source rock changes phase from volatile oil to dry gas coincident to changes in the nature of the reservoir.”

Wet and Wild

The Mancos traditionally has been viewed as a source rock of oil and natural gas and as a seal for conventional reservoirs, according to AAPG member Ron Broadhead, senior petroleum geologist at the New Mexico Bureau of Geology and Mineral Resources.

He provided some highlights:

- ▶ Mancos shales are organic-hydrocarbon source rocks.
- ▶ The oil window is in the shallow southern part of the basin.
- ▶ The thermogenic gas window is in the deeper northern part of the basin.
- ▶ Its maturation is influenced by the depth and proximity to the Tertiary San Juan volcanic field of southern Colorado.

A contribution to the New Mexico Geological Society Field Trip guidebook in 1974, courtesy of the late AAPG member C.M. Molenaar at Shell Oil Co., offered insight on the Gallup sandstone:

“Generally, the Gallup sandstone consists of northeastward prograding coastal barrier strand plain or delta front sandstones that grade seaward into offshore marine mudstones of the Mancos shale ... The Gallup sandstone on the west side of the San Juan Basin displays considerable lithofacies variation owing to a major fluvial system, which contributed sediments.”

WPX Energy made a significant natural gas find in the Mancos in 2010, but dry gas was so yesterday at the time.

So the company opted to explore the wet gas/condensate and oil windows in the central and southern parts of the San Juan Basin.

“While the wet gas/condensate window didn't appear prospective, we found a unique body of sand encased in the Mancos shale along the southern margin of the basin, which the industry refers to as the Gallup sandstone,” Steve Natali, senior vice president of exploration at WPX, said at the time.

Four vertically drilled exploratory wells later, they had confirmed a major oil discovery.

Including the original four wells, the company has drilled 16 Gallup oil wells effective February 2014, with 29 wells planned for this calendar year.

Following the pilot holes, horizontal drilling and hydraulic fracturing became the technologies-of-choice for this success in the Gallup. ■

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Lights! Camera! Action!

Student Chapters Showcase Filmmaking Skills

By BARRY FRIEDMAN, EXPLORER Correspondent

AAPG Student chapters at universities and colleges all over the world – and they're filled with creative, energetic, iconic students who grew up on music videos and games, and know as much about social media as they do oil and gas plays.

And since they also know rocks, AAPG had an idea some years back to hold an AAPG Student Chapter YouTube video contest as a way of promoting the profession while also highlighting the activities of the specific schools and clubs.

The contest did something else, too – it was the catalyst that unleashed the creativity of geoscience students that many do not see.

In short, why not combine all that they want to become with all who they presently are? That was the thinking behind the AAPG YouTube Video Contest.

The rules? The videos could be no more than three minutes.

And that pretty much covered it.

With freedom like that, what student chapter *wouldn't* want to be part of the fun?

Sixteen schools participated in this year's contest, with all the videos shown and the winners announced at the Student Chapter Reception, which is held each year at the AAPG Annual Convention and Exhibition.

This year's winner: San Diego State University. Finishing second was the team from the University of Padjadjaran,



CARRASCO

"It's a great way to share ideas with distant chapters that we would otherwise rarely be in contact with."



WESSEL

students excited to participate in the AAPG and implementing successful practices into our own chapter," he said. "It's a great way to share ideas with distant chapters that we would otherwise rarely be in contact with.

"Another thing we always hope for when making our video entries for the YouTube contest is the possibility that students

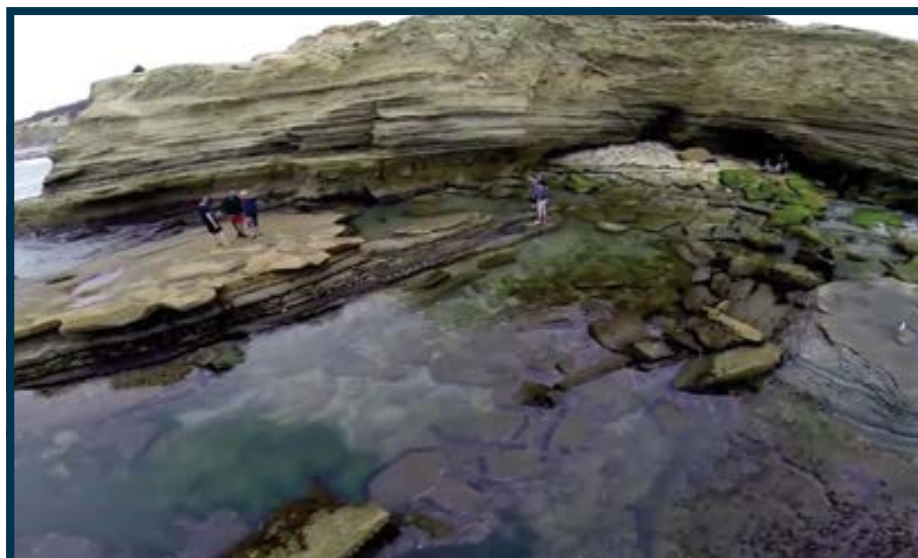
outside the organization might see it and be interested enough to look up who we are and what we do and learn how joining the AAPG could lead them to incredible opportunities," he said.

"Thanks to the social media-based popular vote, Student chapters have that venue to share their passions for geology and energy exploration with others around the world."

AAPG's Mike Mlynek said Carrasco's response was right in line with what organizers intended when they started the contest a few years back: sharing the energy of these students and ginning up the excitement of the profession.

"We've been doing it a couple of years," he said, adding that the Student Chapter Committee wanted to honor what these students are doing below the AAPG radar.

"The videos allow them to show their chapters on YouTube," Mlynek added – and the videos, frankly, feature a professionalism



A scene from San Diego State University's award-winning video.

Bandung, Indonesia, and the Colorado School of Mines took third place.

Taylor Carrasco, SDSU's team leader, said this contest is a great idea.

"The most anticipated part of the contest for us at San Diego State University is getting to see the videos produced by other Student chapters, learning new ways to get

Continued on next page



Continued from previous page

that took him by surprise.

"The quality of the videos is better than anything we used to have on our old website," he said about what would be found at www.aapg.org a few years ago.

"I sit and watch all these videos and I think, hey, these kids are geology students. Are they amateur filmmakers in their spare time?" he said. I mean, what's going on here? And the videos are getting better each year."

As for this year's winning video, Mlynek was impressed by what he saw from SDSU and amused by what he heard, knowing that imitation is the sincerest form of flattery.

"I did notice they had pirated some Scott Tinker audio in there from SWITCH," he said about the past AAPG president's award-winning documentary that has been shown both commercially and to private groups around the world.

"When I saw Scott in Houston at the annual convention, I asked him about it," he said.

And?

"He was fine," Mlynek said, laughing.

"San Diego State had a good run this year," he continued. "They made the finals of the IBA and won the YouTube Videos."

(And not that it's a make or break deal, but the winners for the YouTube contest receive \$1,000 for the top video; \$300 for second prize; and \$100 for third.)

Also on the SDSU team was Kaitlin Wessel, who is featured in the three-minute video and who said there's another dynamic at work.

"The video is also a great way to get students noticed in the community," she said. "Adding student interviews or highlighting student success in the video will subsequently get students' faces and

names out there for prospective employers to see."

SDSU's winning video was coincidentally shown as the lead-in video to the convention's opening session – before it had been announced as this year's winning effort – earning an enthusiastic round of applause from the audience.

The video itself is both understated and powerful, de-mystifying energy – "It's not a right," said a student in it, "it's a commodity" – while talking about how student groups, both at SDSU and elsewhere, are the lifeblood of the organization and the profession.

Couple that with gorgeous shots of San Diego beaches (and how tough was that?) and it's an impressive three-minute piece of filmmaking.

Winners are chosen by a combination of "Likes" received on YouTube and Facebook and from ratings by student chapter committees.


Wessel didn't want to get away without a special shout-out to someone on her team – Taylor Carrasco.

"He single-handedly put this video together with late nights collecting video clips, organizing interviews and editing," she said. "He has created the videos for SDSU the past two years and has done an incredible job ... I don't know what we will do once he graduates!"

Ah, yes, graduation. The future.

The video addresses that. One of the students says at the end, "We have to think about energy this century differently than we did last century."

Good to know some of the people in this video, some of these students, will be doing just that.

To see all 2014 Student Chapter YouTube Videos go to: www.youtube.com/user/aapgweb/playlists. 



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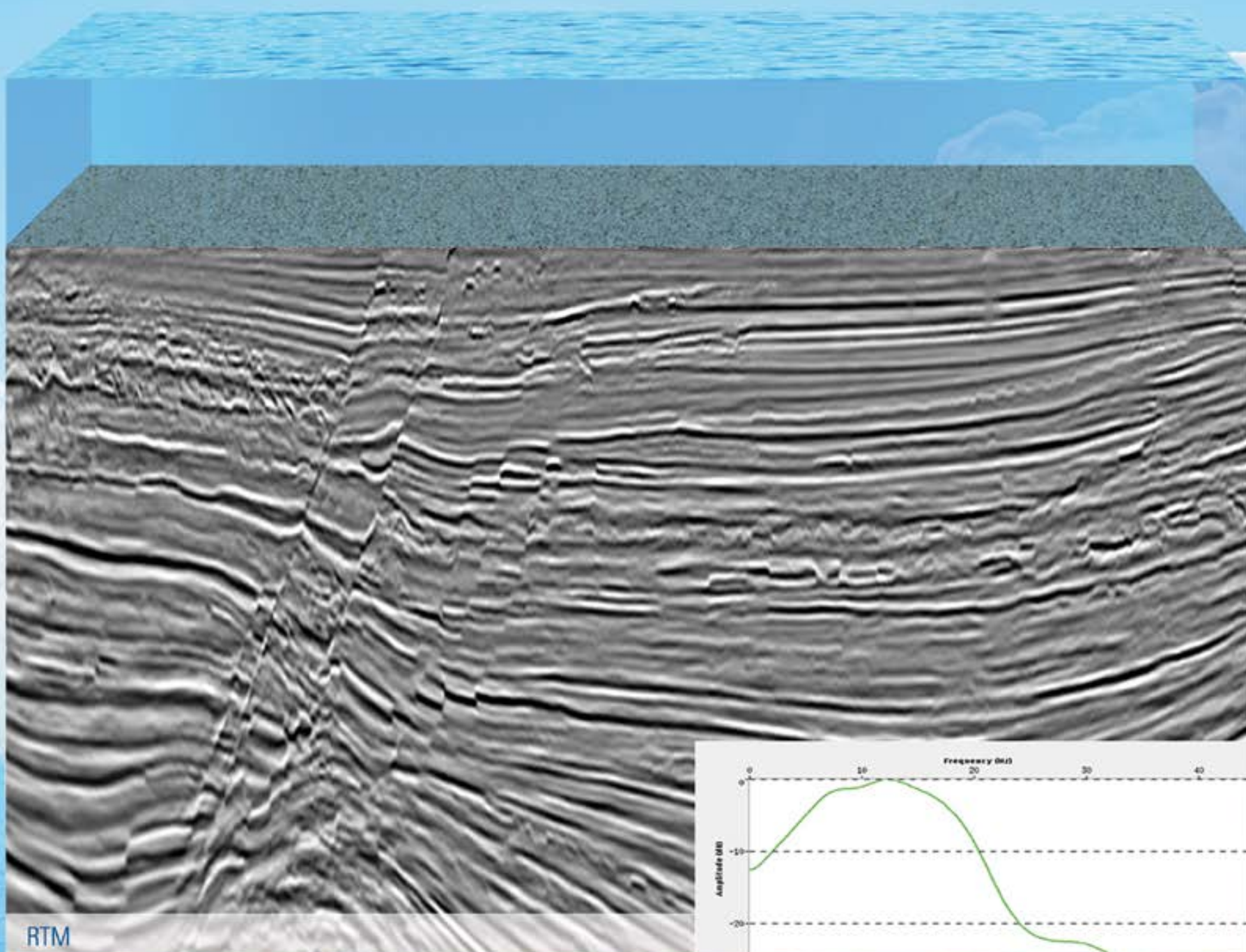
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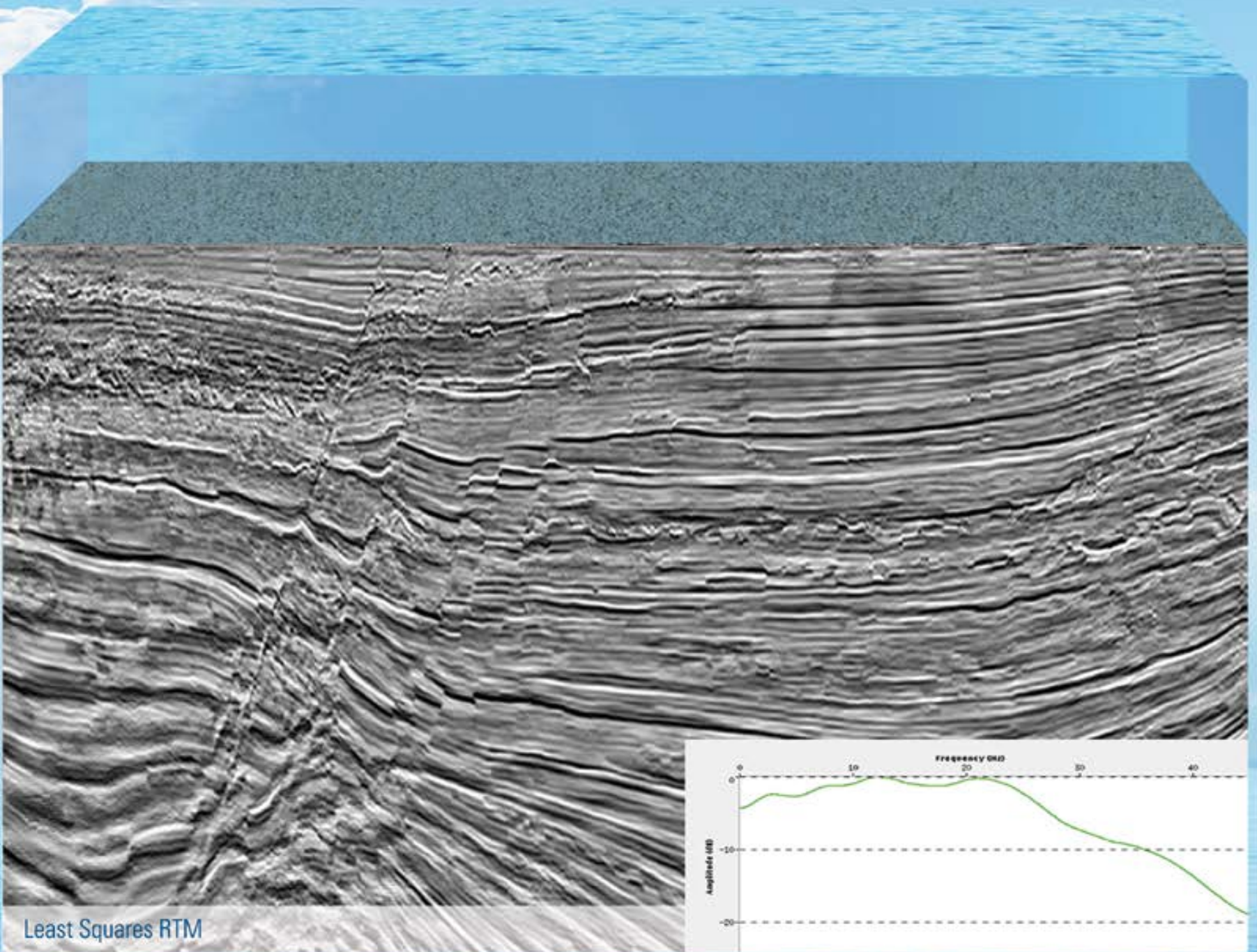
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Microseismic Proving Its Value in Bakken Play

By KEN MILAM, EXPLORER Correspondent

Microseismic technology continues to pay its way as an exploration tool.

A buried array installed in the Williston Basin is helping Newfield Exploration Co. of Denver increase efficiency, according to company geologists.

The array took 41 days to install in early 2012 and covers 58 square miles, with 229 holes, or stations, spaced about 3,000 feet apart with geophones placed at 300, 250 and 200 feet, according to AAPG member and Newfield geologist Laura Johnson.



JOHNSON

"The array has proved to be useful in mapping microseismicity during hydraulic fracturing in the Middle Bakken and Three Forks reservoirs," Johnson said.

"The primary target reservoirs are the Middle Bakken and Upper Three Forks. In our study area the Middle Bakken is approximately 35 feet thick and the Upper Three Forks is 30 feet thick. The vertical distance between two laterals in these reservoirs in our area is approximately 70 feet," she added.

"This work has helped enhance recovery mainly by helping us understand how many wells we need to drill to economically develop our field area. We also believe that by frac-protecting offset wells we enhance recovery by getting more effective fracs on new wells and protecting the existing wells," Johnson continued.

AAPG member Laura Johnson will present the paper "Newfield's Williston Buried Array Microseismic - Pushing the Envelope and Integrating Data" at 3 p.m.

Monday, July 21, during the AAPG Rocky Mountain Section annual meeting. The RMS meeting runs July 20-22 in Denver at the Colorado Convention Center.

"We confirmed microseismic event trends with chemical and radioactive tracers as well as downhole pressure and temperature anomalies in offset wells," she said. "We used the results to understand hydraulic versus effective stimulation. We use variable fracture geometries in our reservoir models rather than running a simple constant fracture half-length and height. This modeling

is being used to help us understand spacing, driving how many wells we drill in each reservoir.

"We also used the results to design our completion order laterally and vertically when completing multi-well pads and near existing wells," she continued. "We now frac the well nearest the existing producer to build up pressure and frac protect the next wells to complete."

Johnson said the company also refrains from drilling within 1,200 feet of a well that has been hydraulically fractured within the previous six months.

Challenges Continue

Three pilot areas were chosen: two designed to test infilling a drilling spacing unit with an existing well and production and the other as "relatively virgin, meaning minimal existing production. We knew we had both situations in front of us to develop," Johnson said.

The situation has not been without challenges.

"The induced fracture heights are poorly calibrated in our buried array data. We knew this parameter would have greater error with the buried array technology. The best way to constrain it would be to run borehole microseismic but we have not done that yet. This has made it difficult to understand vertical stimulation geometries and effects between the Middle Bakken and Three Forks, our two main reservoirs," Johnson explained.

She said there is room to push the envelope further to "continue to understand how the reservoirs complete and interact and what we can do to best drive enhanced recovery from the reservoirs."

"I think a leading next step for microseismic is to tie the microseismic events to completion parameters to help us tweak pump rates, fluids, proppant," she said, "to better stimulate the reservoirs and get more oil out for less money."

RMS Annual Meeting Set July 20-22

"Cracking the Source" is the theme for this year's Rocky Mountain Section meeting, slated July 20-22 at the Colorado Convention Center in Denver.

The theme is intended to focus on the source rocks of the Rocky Mountain area and their impact on the unconventional resources of the region.

The meeting, hosted by the Rocky Mountain Association of Geologists, will include over 100 presentations covering not only source rocks, but also other topics such as technologies used in the identification, characterization and exploitation of these reservoirs, and new insights on the structure and stratigraphy of the Rockies and beyond.

Presentations will range from oral to

poster to core poster.

Also offered are four field trips, with one especially designed and offered for young professionals and students: It will tour the outcrops near the city with a focus on the region's structure and stratigraphy.

The three other field trips, open to all geologists, are:

- ▶ One that focuses on the strata of the Eagle Basin.
- ▶ Two to study the Cretaceous and Paleozoic reservoir rocks, respectively, of the Denver Basin.

Those registering for the meeting before June 1 can save \$100 in fees.

For registration, exhibitor and sponsor opportunities, and other information, visit the website at www.aapgms.org/2014.



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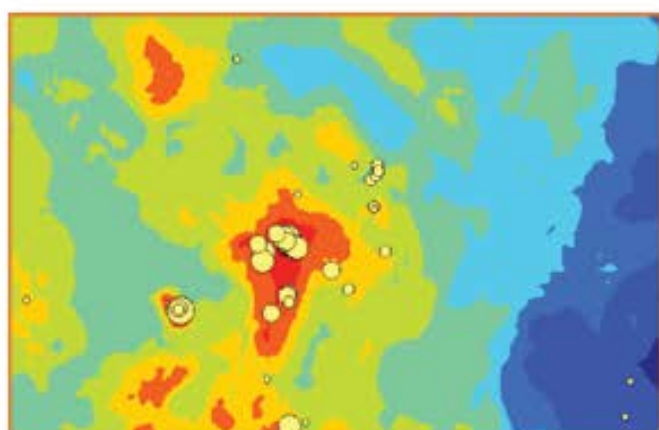
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Nowhere to hide in Tioga County

Multi-measurement imaging reveals secrets of the elusive Marcellus



Sweet spot map (zoom) over a roughly 200-square-mile area in Tioga County, Pennsylvania. Hot colors indicate areas most similar to best producing wells in the region. Circles are sized to the first six months of production for all horizontal wells.

Thanks to unconventional drilling and extraction techniques, the Appalachian Basin has experienced a multi-billion dollar economic resurgence. In Tioga County, Pennsylvania, a methodology called Multi-measurement Interpretation (MMI) has been introduced by NEOS GeoSolutions to provide a better understanding of the basin.

NEOS acquired airborne geophysical data – magnetic, electromagnetic (EM), radiometric, gravity, and hyperspectral – over 1,000 square miles of Tioga County. These data were integrated with existing geophysical, geochemical, and seismic measurements from various public domain and third-party sources and interpreted by NEOS and operator geoscientists. This low-impact,

environmentally friendly approach revealed subsurface features from the basement to the surface, helping explorationists pinpoint the sweet spots and avoid shallow gas geo-hazards in the play.

Using hyperspectral analysis, which classifies substances on the surface based on unique spectral signatures associated with the reflectance and absorption of both visible and invisible light, interpreters located numerous oil seeps and gas plumes. Of these, 90% were verified by geo-technicians on the ground. The seeps and plumes were then traced back into the subsurface along various pathways, including faults that had been mapped using an analysis of magnetic, seismic, log, and EM data.

Airborne EM resistivity measurements provided insights into both lateral and vertical resistivity variations throughout the geologic column, down to roughly 10,000 feet. When the EM voxel was depth-sliced at the Marcellus interval, geoscientists noted that resistive hot spots in the Marcellus corresponded to many of the county's "best well" locations.

In addition to analyzing the airborne datasets, geoscientists on the project also incorporated more traditional geophysical measurements into the interpretation. Well logs were analyzed to enhance structural control and to calibrate the airborne EM data. Seismic data were incorporated into the regional structural model and, in combination with the magnetic and EM data, provided insights into how faults were creating pathways for hydrocarbons to migrate toward the surface.

Finally, a cutting-edge geostatistical technique called predictive analytics was applied. The technique allowed geoscientists to mine all geo-datasets for subtle patterns and correlations that corresponded to the best wells, and to then pattern search for similar "correlative attributes" in areas that had yet to be drilled. This helped the project's underwriters to optimize their leasing, drilling, and hydraulic fracturing programs and to target future ground-based geophysical acquisitions in the most promising areas.

MMI has captured the attention of the region's major E&P producers. Since the early surveys in Tioga, NEOS has undertaken additional projects in Pennsylvania, compiling nearly 5,000 square miles of available regional data that are delivering unique, cost-effective insights into the Marcellus and Utica shale plays.

▶▶▶ To learn more about this project or others in the *Unlock the Potential* series, visit: www.ThePotentialUnlocked.com

HIGHLIGHTS

KEY TECHNOLOGIES:

- MAGNETIC
- PASSIVE-SOURCE EM
- RADIOMETRIC
- GRAVITY
- HYPERSPECTRAL
- PREDICTIVE ANALYTICS

AREA: Appalachian Basin, Pennsylvania

CUSTOMER: Supermajor

FOCUS: Regional Mapping

TYPE: Unconventional

KEY INTERPRETIVE PRODUCTS:

- Regional resistivity voxels down to 10,000 feet
- Maps of lineaments, fault networks, and intrusives
- Maps of regional prospectivity derived via predictive analytics

CUSTOMER BENEFITS:

Cost-effective regional insight depicting the most (and least) prospective areas for leasing, drilling, or further geological and geophysical (G&G) study.



'Real promise' met real challenges

Alaska: Early Frustrations Led to Later Success

By ROSS COEN

The history of oil development in Alaska is often presented as a heroic tale, but long before the 1968 discovery of the Prudhoe Bay field (16 billion barrels and counting), the industry experience was marked by a great deal of frustration and failure.

The Bear Creek well drilled in 1957 by Shell and Humble Oil is representative of the high-stakes gamble that is oil exploration in the Arctic.

Like many other American oil companies, Humble Oil – a company today known as Exxon – expanded and diversified its operations in the 1950s, an era of economic growth and increased oil consumption. From 1947 to 1956, the number of Humble's producing U.S. wells increased from 8,976 to 13,145. Expenditures for drilling in the same time period more than doubled from \$50.5 million to \$127.5 million.

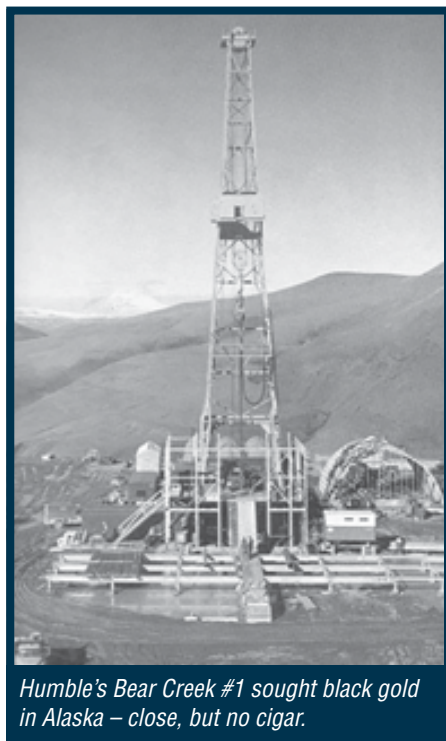
Although most of this activity took place in Texas and the Gulf Coast, Humble also looked north to Alaska.

Pratt's Prophecy

AAPG legend Wallace Pratt, Humble's



COEN



Humble's Bear Creek #1 sought black gold in Alaska – close, but no cigar.

chief geologist and renowned sage of oil exploration, encouraged Alaskan development as early as 1944.

"A promising region is the Alaska Peninsula. Its accessible southern coast exhibits seepages of petroleum at Cold Bay," he said. "Three successful test wells have been drilled on the peninsula [and] obviously further exploration is



DAVIS

justified in this region."

Humble sent geological and aerial survey crews to southwest Alaska from 1954 to 1956. The crews explored the coastline near the village of Cold Bay and observed an outcrop of Upper Triassic carbonates, a particular formation of exposed layers along the Bear Creek anticline, the angular unconformity of

which suggested the subsurface geology might be an ideal trap for crude oil.

Surface seeps of crude had been found across the region for more than a century, which only bolstered Humble's confidence.

On April 25, 1957, Humble formed a partnership with Shell, agreeing to drill three wells on Shell's leases at Bear Creek, Ugashik Creek and Wide Bay in return for a 50 percent interest in the 250,000-acre field. Drilling on the Bear Creek No. 1 well began in September that year, and by the end of 1957 the well had reached a depth of 6,585 feet.

Humble's annual report summed up the effort in a single sentence: "The remote location, severe cold and high winds have presented unusual difficulties."

Humble President Morgan Davis (a past AAPG president) spoke to the Anchorage Chamber of Commerce in August 1958, proudly hailing the Bear Creek well and stating that Alaska had "real promise" in the oil business. Humble was eager, he stated, "to have a try at the riskiest and most expensive kind of hunting your state has to offer: wildcatting for oil."

Davis's visit came just as Alaska was preparing to enter the union as the 49th state. His confidence buoyed hopes for

[See Alaska, page 36](#)

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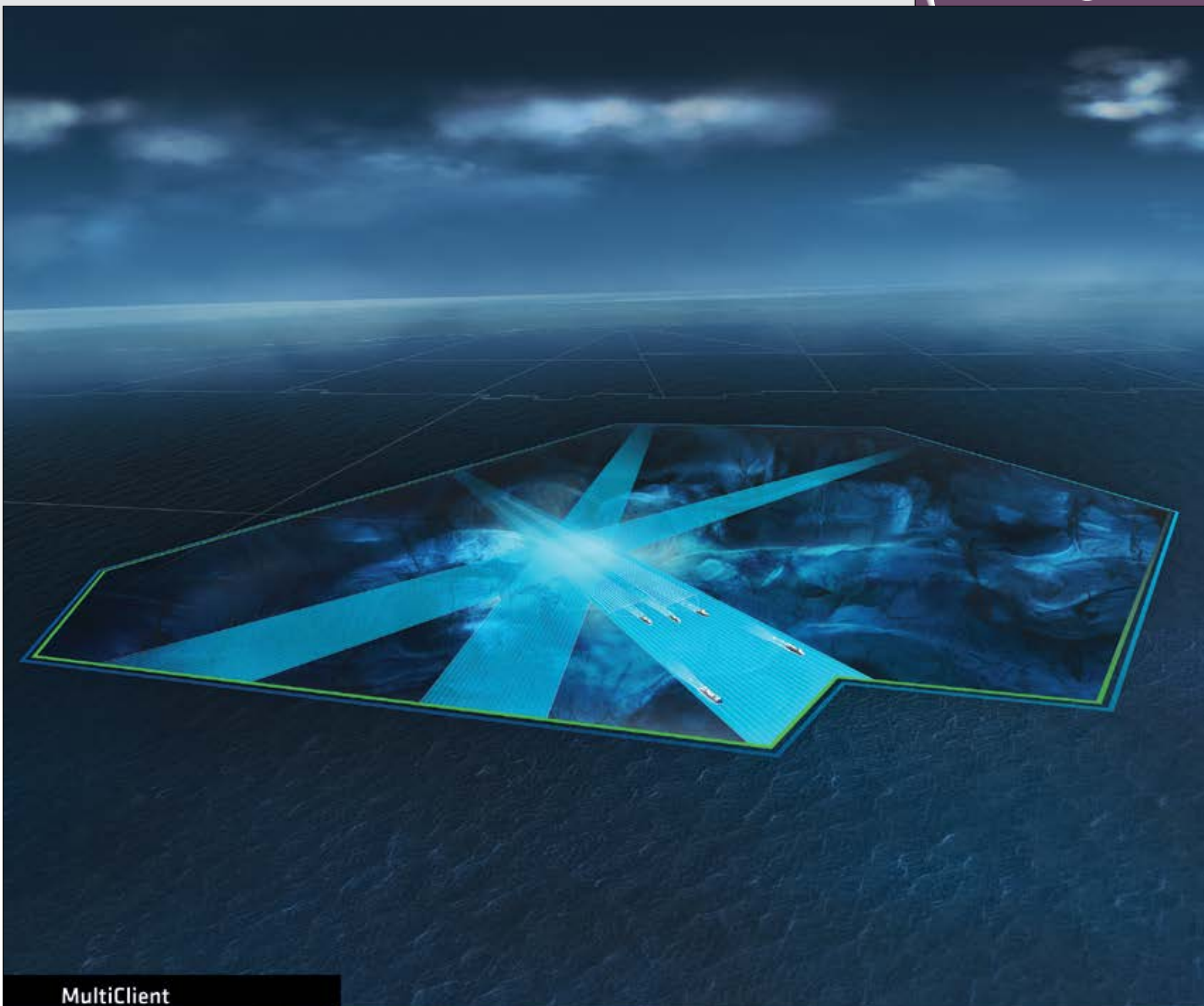
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Saline Water in Bakken: Where Did it Come From?

By LOUISE S. DURHAM, EXPLORER Correspondent

The now-famous Bakken formation has produced its billionth barrel and counting.

No matter this milestone, research continues.

There's always something more to learn.

AAPG member Zell Peterman, U.S.

Geological Survey scientist emeritus, is busy with colleagues examining Williston Basin Bakken formation water and the role of shale filtration.

"Upper and Lower members of the Bakken are organic-rich black shales that were deposited in deep anoxic environments," Peterman noted. "The middle unit is mostly a fine-grained, commonly dolomitic, siltstone deposited in a



PETERMAN

"The Bakken production can't be blamed for previous contamination ... Our aim is to understand the origin of the brines."

shallower environment.

"Water from wells producing oil out of the Bakken is about an order of magnitude more saline (27 to 34 percent) than modern sea water (3.5 percent)," he said. "Evaporation of sea water in tidal flats and

dissolution of evaporites are commonly proposed mechanisms to explain saline water in deep formations.

"The latter is the prevailing explanation of saline waters in carbonate and some clastic reservoirs in the Williston Basin,"

Peterman commented. "But neither process adequately explains the salinity and element ratios of Bakken formation water."

Consequently, Peterman and others are conducting an isotopic and geochemical study of this formation water (brine) to elevate understanding of the long-term hydrodynamics of this unit.

The analysis will enable the group to compare their findings with formation water from adjacent units and to constrain the origin and evolution of the water, according to Peterman.

"Strontium isotopes, as shown by previous workers, are especially useful in compartmentalization within a stratigraphic unit," he emphasized. "Stable isotopes provide information on the origin of the water itself, and dissolved constituents record the effect of long-term water-rock interaction and potential mixing of different waters."

Ion Filters?

The group has been studying formation waters in the Williston Basin for some time, beginning at the Fort Peck Reservation oil field in Roosevelt County, Montana, where the Mississippian-age Charles formation has been pumping out oil for 60 years.

The Charles is a conventional reservoir, and some of the older wells are producing 100 barrels of brine for every barrel of oil.

The formation water study there was environmentally related.

"Those brines in the injection wells are so salty they corroded the casings and the brines were coming back up and contaminating the shallow aquifer," Peterman said.

"I had some data saying the Bakken brines are different than what's in the Mississippian carbonates such as the Charles formation," he said.

So they decided to take a look-see to ascertain if the Bakken brines are distinct, which means they can be separated from the older brines.

"If they're different, then the Bakken production can't be blamed for previous contamination," Peterman emphasized. "Our aim is to understand the origin of the brines."

Oil field brines have been studied for decades, and various theories have been proposed as to how they form and what they mean.

Saline water in the Bakken can't be attributed to dissolved evaporite deposits, as the Bakken doesn't contain any evaporites, according to Peterman.

On the other hand, you can't look to salt concentration coming from evaporation of seawater in a tidal flat environment because the Bakken rocks weren't formed in a tidal flat.

Peterman presents his group's proposed resolution to this conundrum.

"When the Bakken silts were deposited, they had a lot of sea water in them, perhaps up to 50 percent by volume," he said.

"As the younger rocks were deposited and compressed, our hypothesis – and only a hypothesis – is that at some point the two shales on top and bottom became what you might call ion filters," Peterman stated. "Then, as the water was expelled, the salt was left behind."

Admittedly not an oil geologist, Peterman asserted that the oil companies' interest likely will be piqued by this type of study to understand the fluid history of their reservoir rocks. ■

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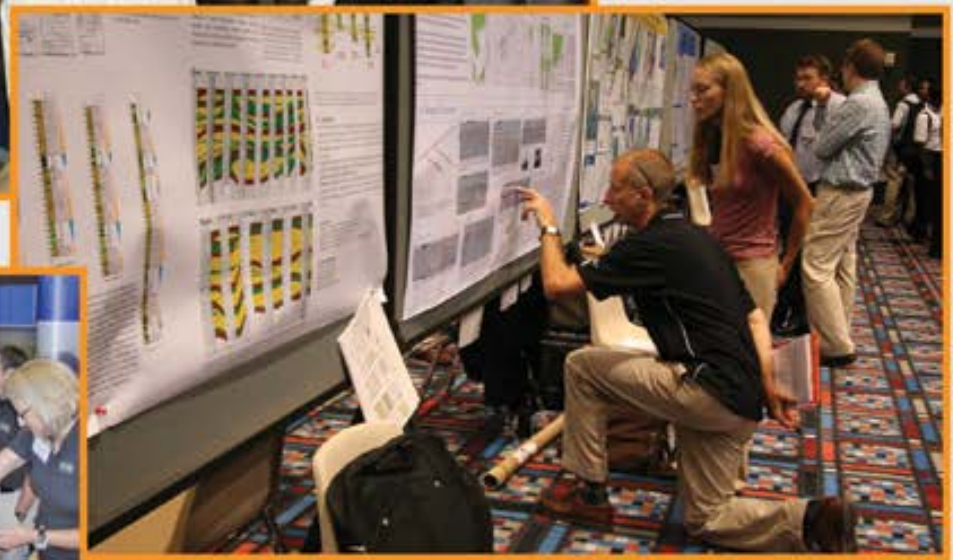
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Editor's note: Ross Coen is a doctorate student in history at the University of Washington where he studies the political and technological history of resource development in Alaska and the Arctic. This article is excerpted from his 2012 book, "Breaking Ice for Arctic Oil," which examines the history of ExxonMobil's oil transportation systems in Alaska.

Walters: Industry Must Improve Communication Skills

By DIANE FREEMAN, EXPLORER Correspondent

The energy industry needs to do a better job of engaging communities near drilling sites and informing them of safe energy practices that protect human health and the environment, according to one Colorado engineer.

Craig Walters, Anadarko Petroleum's director of Wattenberg field operations in northern Colorado, said his company has taken steps to improve communication with stakeholders affected by the company's drilling activities and assure them of the business' environmental and safety excellence.

"We want to make sure it's a positive experience for everybody when the drilling rigs show up," he said.

Walters made his remarks earlier this

year as one of the speakers at the annual 3-D Seismic Symposium in Denver.

"Historically, the first exposure that the public has to drilling is when the seismic truck shows up," he said. "Usually seismic is incentivized to get in and get out fast, and often is handled by contractors."

When asked by the public whom they work for, these contractors typically identify the operator, he said.

Anadarko now asks seismic crews to hand out business cards to the public so they can contact the company to get their questions answered.

"This program has been hugely successful," Walters said. "You've got to have open communication but also effective communication. You have to listen

to them. We can't incorporate everything they would like but when we can, we definitely try to."

For example, Anadarko tries to use smaller vib trucks in neighborhoods as well as fail-safe vibrator protection. It also has adopted a flexible shooting schedule from 9 a.m. to 5 p.m., and tries to stay off neighborhood roads when school buses are out, he said.

Walters also said the energy industry needs to let the public know how it contributes to the community.

"We employ more than 1,500 people in Colorado and 100 indirect employees for every drilling rig," he said. "Our average wage is 52 percent higher than the state average." ■

Alaska from page 32

the economic future of Alaska.

"Our company's policy has never dictated that we enter into an area such as Alaska on a short-term basis," he said, "nor that we pull out if our first ventures prove unsuccessful."

A Bad Choice?

Tough times were ahead for Bear Creek, however, and Davis would eat his words soon enough.

Of the five total drill-stem tests conducted at different depths, only one recovered a consistent show of crude oil. Humble geologists came to suspect the Bear Creek No. 1 well did not penetrate the Triassic strata associated with the exposed outcrop at Cold Bay. By March 1959, Humble and Shell agreed to plug the well.

At a total depth of 14,375 feet and a cost of \$7 million, Bear Creek No. 1 was the most expensive dry hole in company history. A company vice president said simply, "We made a bad choice there."

"The year 1958 presented many difficult problems for the domestic petroleum industry," Davis dryly noted in a shareholder report. "Weak demand, large inventories and excessive imports created downward pressures on prices of both products and crude oil."

The company's exploration expenses decreased from \$235.4 million in 1957 to \$154.9 million in 1958, while the number of completed wells dropped from 867 to 557 in the same period. That the company was now drilling for oil in new, high-risk regions such as Alaska was reflected in the "dry hole costs," which accounted for a record 45 percent of total drilling expenditures in 1958.

On July 19, 1960, Humble announced it was closing its Anchorage office and sending 11 of its 12 employees back to Houston. A lone scout would remain in Alaska to monitor the progress of the other oil companies exploring in the state.

"I can't deny this indicates a definite downgrading of interest in Alaska by Humble," stated geologist Fred Sollars, who cited the region's high operating costs and the downturn in world oil demand as the principle reasons behind the move.

Delayed Gratification

Just four years later, however, Humble entered into a 50-50 Alaska partnership with the Richfield Oil Company of Los Angeles. And just four years after that, the companies drilled an exploration well on the Alaska North Slope near a small, unremarkable cove called Prudhoe Bay.

The discovery of the continent's largest oil reservoir set off an exploration and development frenzy that transformed the intertwined histories of the oil industry and the state of Alaska.

Humble's \$20 million investment in 1964 would bring billions in revenue to the company in the ensuing decades. Furthermore, the success of Humble – renamed Exxon in 1973 – forged an inexorable bond between the company and the state, a partnership of sorts in which both parties found their respective self-interest (i.e., maximizing revenue) simultaneously aligned and in conflict.

To say that Exxon has exerted an influence on the history of Alaska since 1968 is an understatement. The reverse also is clearly true. ■

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Mexico's Potential Open to Global Attention

By ALFREDO E. GUZMÁN and CLAUDIO BARTOLINI

On Dec. 20 last year, Mexico's President Enrique Nieto signed into law constitutional modifications made by Congress in the energy sector that have to do with oil, gas and electricity that, while reaffirming the nation's full ownership of all hydrocarbons in place and its exclusivity and control over them, lifted the state monopoly over activities related to their search and extraction.

Oil and gas exploration and production activities can now be carried on not only by Pemex, the national oil company, but the state also can now do so with private companies under industry-standard contract models, such as production sharing, profit sharing or exploration licenses, which were all previously forbidden by the constitution.

The new laws modify Pemex's charter, which until then was just another state agency subject to all kinds of bureaucratic restrictions, and convert it into a "State Productive Enterprise" with norms and regulations similar to those dictated by industry's best practices, and gives it the conditions needed to operate as any international oil enterprise would, being able to do joint ventures and contracts with any third party as it sees fit to fulfill its charter.

Additional terms were established in the decree not included as constitutional changes that will be normed and regulated through secondary laws, such as:

- ▶ The treasury department (Hacienda) will establish the royalties and contributions to be paid for the extracted products.
- ▶ Companies may book for accounting and financial purposes the expected benefits from their licenses or contracts but not the reserves.
- ▶ Pemex, through a Round "0," will



GUZMÁN



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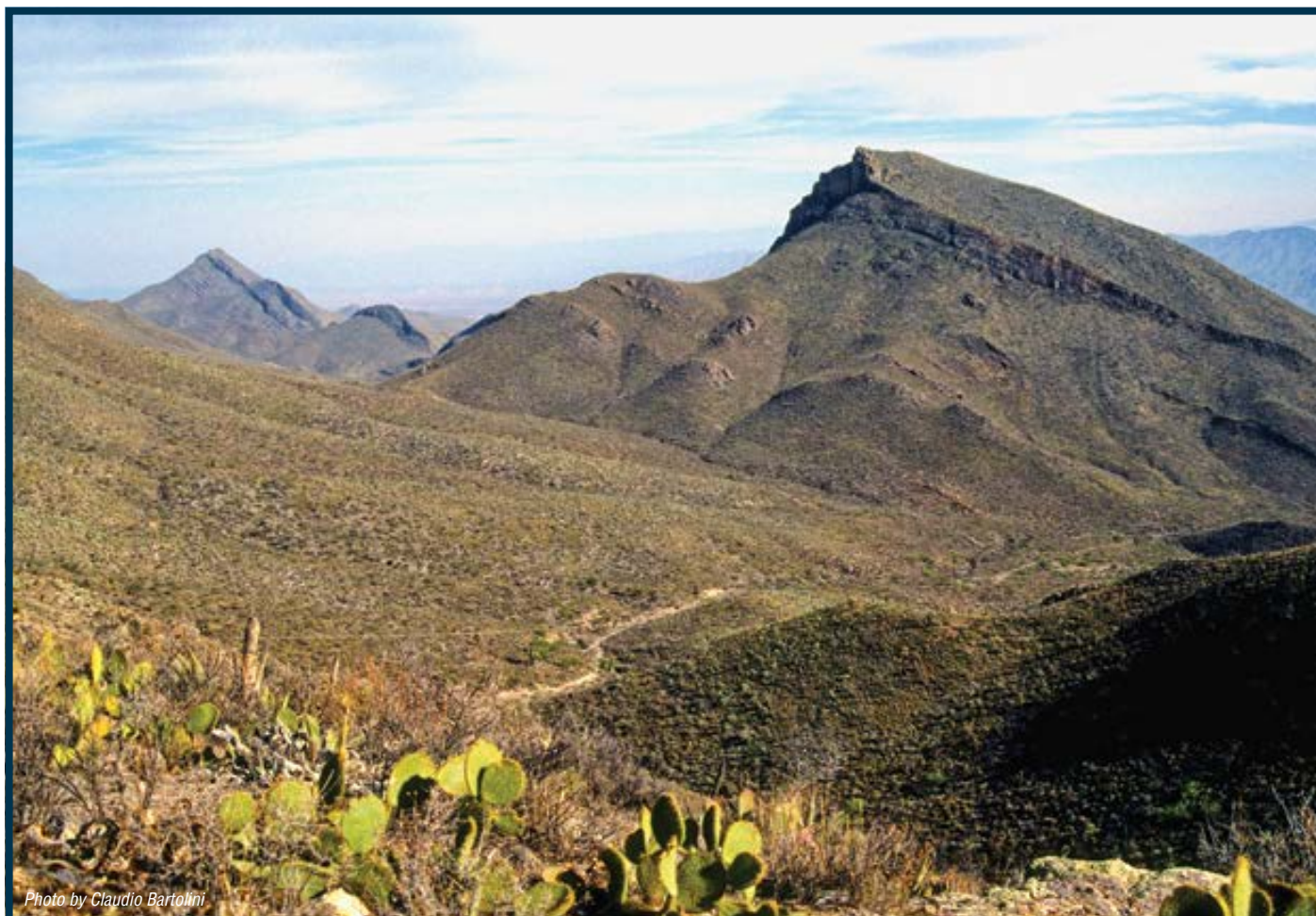


Photo by Claudio Bartolini

Thanks to the recent constitutional changes, outside companies have reason to be excited about potential and exploration in Mexico. Above, volcanic-sedimentary sequences of the Jurassic Nazas Formation at the San Julian Anticlinorium, Caopas, central Zacatecas, Mexico.

have first choice on licenses and may operate them with participation of private companies. The Energy Secretariat (SENER) and the National Hydrocarbon Commission (CNH) will select the partners and manage and control the contracts.

- ▶ Contracts and licenses shall have a "National Content."
- ▶ E&P (and electricity) activities will have preference over any other for land and subsurface uses.
- ▶ Contracts must have public transparency clauses, will be auditable, awarded with maximum transparency and all terms will be public.
- ▶ Authority and responsibilities over the E&P activities will be on:
 - ✓ SENER advised by CNH will define and conduct policy, award licenses,

select areas to be contracted, establish bid's technical terms and guidelines, and award permits for processing and refining.

- ✓ CNH will manage a geologic and operational database, authorize reconnaissance and surface surveys, carry out bids, establish awardees, sign the contracts, manage the technical issues of the licenses and contracts, supervise operational plans and regulate the E&P.
- ✓ Energy Regulatory Commission (CRE) will regulate midstream and gas products.
- ✓ Hacienda will establish the economic conditions of the contracts in terms of fiscal conditions assuring an income contributor to their long-term development.

processes. CNH will manage a National Hydrocarbons Data Center with all seismic and cores of the E&P works.

After-tax-income and proceedings from E&P licenses and contracts will go into a public trust fund responsible for their payments that will cover government programs, research, petroleum audits and sustainability funds. The trust will continue funding the federal budget at the same proportion of the GDP that it did in 2013.

A "National Natural Gas Control Center" will operate all the trunk pipelines and storage facilities and similarly a "National Energy Control Center" will do the same for electricity.

New legislation will set the bases to assure the protection and care of the environment in all process related to this decree, and new policies will promote cleaner technologies and fuels and Congress will issue a law to regulate the use of geothermal resources.

Additional Changes

In addition, public subsidies of energy products will be phased out.

Also, the CNH and CRE will have new responsibilities, authority and budgeting

[See Mexico, page 40](#)

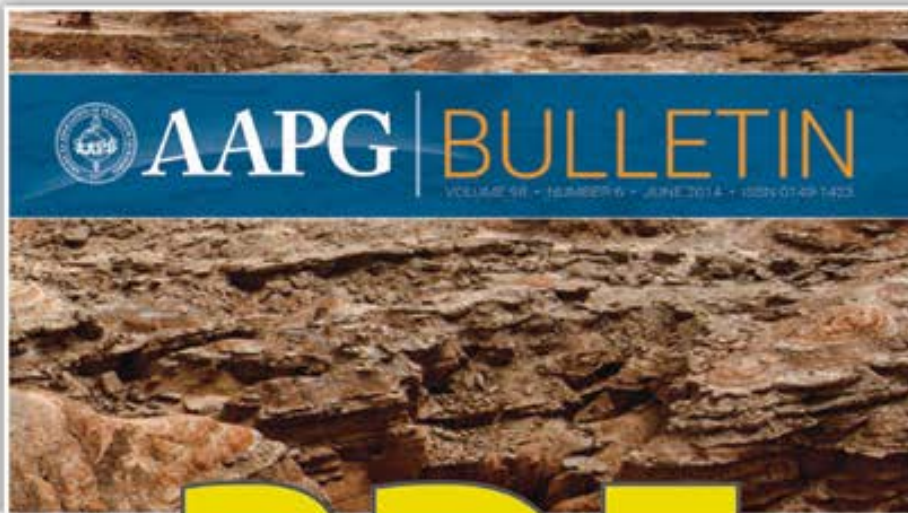


| | Oil BBO | Gas TCF | BBOE |
|---------------------------------------|-------------|-------------|-------------|
| 1. Produced volumes | 40.6 (12%) | 71.6 (15%) | 55.0 (13%) |
| 2. Reserves (3P) | 30.8 (9%) | 63.2 (14%) | 44.5 (10%) |
| 3. Yet to be discovered conventional | 45.3 (13%) | 46.5 (10%) | 54.6 (13%) |
| 4. Yet to be certified unconventional | 31.9 (10%) | 141.5 (30%) | 60.2 (14%) |
| 5. Remnant oil ""not economic"" | 191.9 (56%) | 144.7 (31%) | 220.7 (50%) |
| | 340.5 | 467.5 | 435.0 |

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PREDICTING RESERVOIR PROPERTIES

Neil T. Grant, Alexander J. Middleton, and Stuart Archer

The prediction of reservoir properties in the Skagerrak Formation across the Central Graben, UKCS, has been a challenge due to its variability. This paper analyzes borehole-derived porosity-depth and porosity-effective stress trends and uses them to build a predictive regional model.



POST-DEPLETION SUBSIDENCE

Chandong Chang, Ellen Mallman, and Mark Zoback

Vertical compaction due to pressure drainage in the underlying and overlying shale eventually exceeds that due to depletion and compaction of the sand reservoir. Thus, the calculated subsidence rate due to the shale compaction is higher than the subsidence induced by reservoir depletion.



OFF-FAULT DEFORMATION

Alan P. Morris, Ronald N. McGinnis, and David A. Ferril

Field analysis of a fault in the Balcones fault system, south-central Texas, shows sub-seismic deformation structurally related to seismic scale faulting. Displacement gradient analysis can help predict characteristics of this deformation within a reservoir adjacent to a seismic-scale normal fault.



DIAGENESIS INFLUENCES POROSITY

Arthur H. Saller, David Pollitt, and J. A. D. Dickson

The purpose of this study is to determine, describe, and interpret the diagenesis of the Wafra First Eocene reservoir, Saudi Arabia and Kuwait, and to show its relationship to porosity, permeability, and fluid content. Reservoir characteristics are largely determined by diagenesis.



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Mexico
from page 38

The National Industrial Safety and Environmental Protection Agency of the Hydrocarbon's Sector will be implemented.

The State Productive Enterprises' purpose is to create value and increase the state's income under a special tax regime and special organizational structure based on the best international practices with full technical and management autonomies. Their finances shall not compete and conflict with the federal government's and will have a special regime for acquisitions, leases, contracting of works and services, acquisition of debt and for administrative responsibilities.

The reform will open up numerous business opportunities for the geosciences community in particular and for the upstream industry in general.

New laws will prevent, identify and punish any attempts to influence a public servant to benefit economically.

And finally, Pemex and the Federal Electricity Commission employee unions shall no longer be represented in the Board of Directors of the two companies.

The Reform has the potential to have a huge impact on the energy picture of Mexico and probably of the world, since

it opens up to industry an extremely large resource base: Mexico has discovered in the subsurface 263 BBO of oil and 279 TCF of gas, that doesn't include yet to be found resources in conventionals and unconventional. Including them, the total endowment is considered to be in the order of 435 BBOE (table 1), and this is only for the producing basins.

Of this endowment in 100 years

only 41 BBO and 72 TCF have been extracted, leaving behind an enormous quantity of resources.

Assuming Pemex's numbers for the yet to be found conventional and unconventional resources are correct, and not considering what remnant today is "uneconomic," there are at least 159 BBOE waiting to be produced.

Considering the EUR established by Pemex is based on traditional practices that have forever been hampered by lack of resources, the 220.7 BBOE considered uneconomic represent a huge resource base that, through the application of technology, science and investments, would substantially improve the EUR.

The reform will open up numerous business opportunities for the geosciences community in particular and for the upstream industry in general.

The changes went further than expected.

The specific terms and regulations (secondary laws) will be ready by second quarter 2014 and there will probably be bid rounds as early as third quarter. The government now has a lot of flexibility on the type of contract schemes it may use to improve the energy conditions of Mexico. Success of the reform will depend on the economic models that will be established in the secondary laws.

A Bit of Background

Pemex is the national oil company and, until today, the only operator Mexico has ever had, although a handful of companies are working in the country under service contracts. It was created after the March 18, 1938, expropriation of 17 mostly European oil companies by then-President of Mexico Lázaro Cárdenas, thereby creating a profound sense of nationalism in the country around the oil industry.

The state-owned company was formalized on June 7, 1938; and today is the largest company in Mexico and thirteenth largest in the Americas.

In the 1980s Pemex became one of the most important exporters of petroleum in the world, thanks to the discovery and exploitation of Cantarell, the world's largest offshore field in Campeche Sound, with reserves of 40 BBO. The oil company, due to its excellent production infrastructure and high oil prices, had income of \$US 126 billion in 201 – the largest amount in its history.

Mexico is one of the Latin American countries with enormous petroleum potential.

The country has large petroliferous basins developed mainly around the Gulf of Mexico, both onshore and offshore. The most important petroleum basins being:

- ▶ Southeastern.
- ▶ Veracruz.
- ▶ Tampico-Misantla.
- ▶ Burgos.
- ▶ Sabinas.
- ▶ The Gulf of Mexico proper.

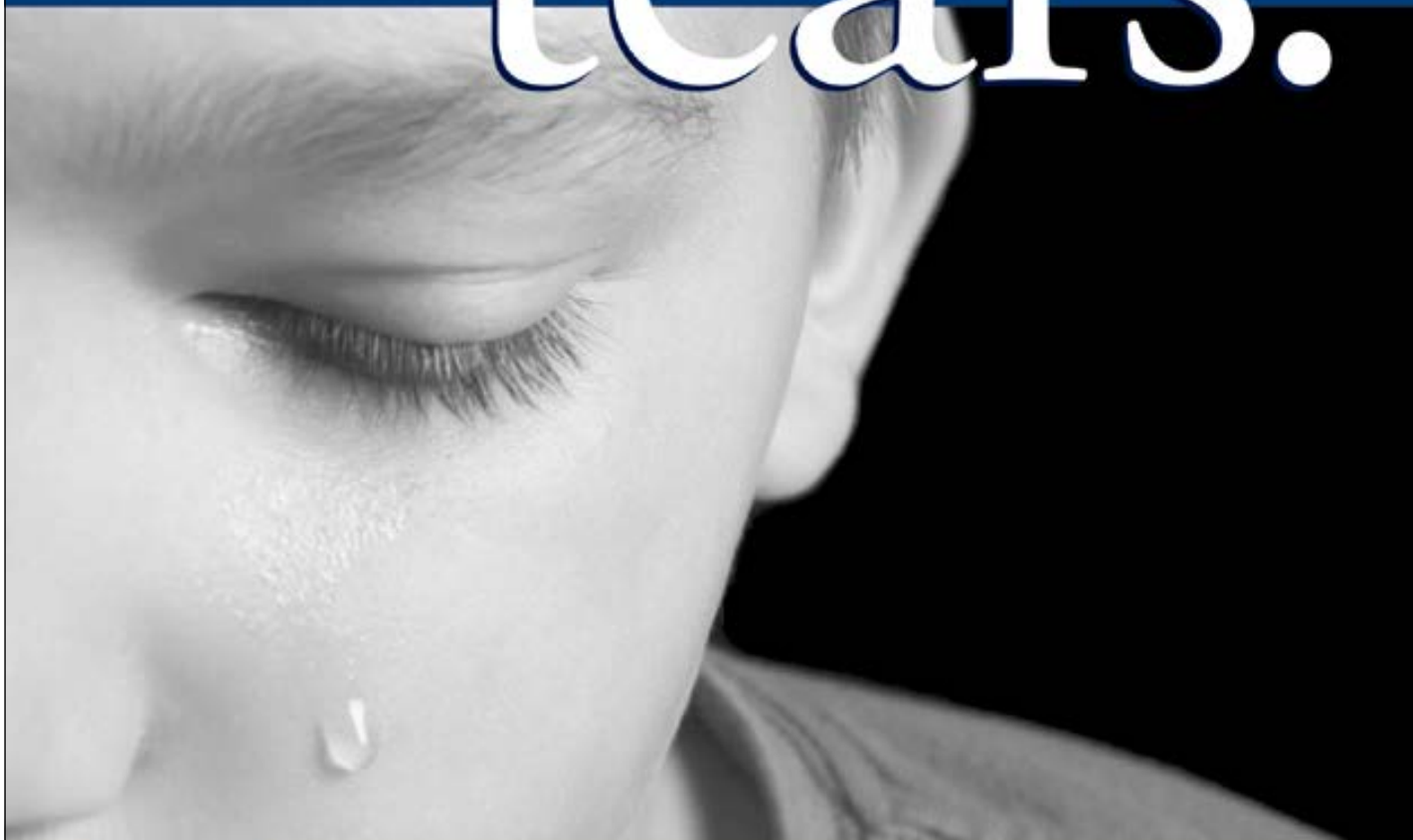
Current reserves (BBOE) are 43 (3P), 26.2 (2P) and 13.8 (1P), with prospective resources of 54.6 BBOE (Pemex, 2012).

Lately, Pemex has focused in the Gulf of Mexico deepwater potential having done in 2013: 10,595 square kilometers of 3-D seismic acquisition, the drilling of four wells, two of which producers invested \$1 billion (USD) that resulted in the discovery of 608 MMBOE of reserves.

See Mexico, page 52

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To Export, or Not To Export – That IS the Question

By EDITH ALLISON, Geoscience and Energy Office Director

It is balmy, even hot, in the United States, so now is the perfect time to ask – do you know where your winter heating energy is?

Last winter's propane shortages in the Midwest and Northeast regions of the United States and super-storm Hurricane Sandy's disruption of diesel and gasoline supplies suggest that government policy and infrastructure weaknesses can unexpectedly waylay energy supplies.

Another reminder that policy and infrastructure can disrupt energy is the threat of possible Russian restrictions of natural gas flow to Europe. (Russia supplies 30 percent of the natural gas used in Europe, and half of that gas moves through Ukraine.)

Some members of Congress are again proposing rules to accelerate the federal approval process for natural gas export facilities, although any benefits would be years in the future.

Congress and the executive branch are working on measures to reduce future U.S. energy supply disruptions:

► On March 21 the Home Heating Emergency Assistance Through Transportation Act of 2014 (HHEATT Act) became law. It temporarily exempted fuel truck drivers from limits on how many hours they could work. This facilitated the movement of propane from Texas refineries to the Midwest.

Also in March, Sen. John Thune (D-S.D.) introduced S. 2086, the Reliable Home

Heating Act. It would allow exemptions to federal motor carrier safety regulations when a governor declares a residential heating fuel emergency.

► A May hearing by the Senate Energy and Natural Resources Committee explored the causes of last winter's propane shortages and possible ways to prevent a similar crisis in the future.

Witnesses suggested that inadequate infrastructure and excessive petroleum product exports were areas that need attention, but additional federal regulations were unnecessary.

► The U.S. Department of Energy (DOE) has just announced the establishment of gasoline reserves in New York Harbor and New England in response to the gasoline shortages caused by Hurricane Sandy.

New York state also has a pilot program to develop a gasoline reserve on Long Island. The DOE established the Northeast Home Heating Oil (diesel) Reserve in 2000; it was not used until Hurricane Sandy in 2012.

Energy Scoreboard

U.S. and global energy production is sufficient to meet demand for many years, and is not the primary source of consumer shortages.

Looking at just a few of the energy fuels that are in the news:

► Propane production has grown almost



ALLISON

50 percent in the past five years, driven by the increase in domestic oil and natural gas production.

Propane exports also are up and represent about 25 percent of production.

Propane stocks, depleted by exceptional demand for drying corn in the fall and for winter heating, fell below the five-year average in fall 2013 and had only

slightly rebounded in April.

To put this in perspective, propane represents less than 2 percent of U.S. energy consumption. However, it is important because propane is the primary heating fuel for over five million homes that are scattered around the country.

► Until recently 80 percent of homes in Maine used fuel oil (diesel) for heating, but many are switching to propane – between 2004 and 2009 propane use doubled, and probably doubled again by end 2012.

► Gasoline and diesel production and exports are at record levels. Volumes in stock represent over 200 days of supply for gasoline and over 100 days of diesel supply. Ethanol production is higher in 2014 than in 2013.

The Northeast, however, has inadequate refining, storage and distribution capacity.

The number of refineries operating there dropped from 14 in 2004 to 10 in 2014, and refining capacity is down almost 25 percent. This strains fuel distribution when bad weather increases demand or closes

refining and distribution facilities, as during Hurricane Sandy.

Infrastructure

Infrastructure appears to be the greatest limitation to assuring energy gets to consumers – and the fundamental problem is that energy supply and energy consumers are located in different places.

Industries that require large amounts of energy for centuries have located close to the energy source. Today, however, the majority of energy consumers are not close to their energy supply: Nine western states, spanning from North Dakota to Texas, produce 46 percent of all U.S. energy (including wind energy) but have only 14 percent of the population.


The United States has an extensive network of pipelines and electric lines to move energy around the country, but recent changes in where energy is produced have made the distribution network less efficient.

Wind energy production, located primarily in California, the Midwest and Texas, increased 200 percent from 2008-13; domestic oil production, primarily from the Bakken formation in the northern plains and the Eagle Ford formation in Texas, increased 50 percent over the same period.

In addition, shale gas production has swelled in the eastern United States.

Policy mandates also are contributing to

Continued on next page



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Sedimentology of Paralic Reservoirs: Recent Advances and their Applications

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The Geological Society, Burlington House, Piccadilly, London



Paralic reservoirs record clastic deposition at or close to sea-level. They reflect a range of depositional environments including deltas, shoreline-shelf systems and estuaries and have provided the backbone of production in many mature basins around the world, currently contributing around 30% of global conventional hydrocarbon production. Strata that host these reservoirs are shaped by a wide variety of depositional processes and controls that reflect the upstream supply of sediment and water, the characteristics of the receiving basin, relative sea-level and tectonic setting. Consequently they exhibit much variability in their stratigraphic architecture and sedimentological heterogeneity, which translates into complex reservoir performances that are challenging to predict. However, new research themes have emerged in recent years: contrasts between regressive and transgressive coastlines; along-strike and cross-shelf variability; shoreline trajectory concepts and the impact of autogenic responses during constant forcing. This conference will address these new themes together with developments in established approaches to discuss the current state of knowledge in the exploration and production of paralic reservoirs.

Themes:

- Modern studies, numerical & experimental modelling of paralic systems
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- Paralic muds & mudstone reservoirs

Core Workshop:
20-21st May 2015 Core Workshop (Weatherford Labs, East Grinstead)
We will be holding a 2-day core workshop immediately after the main conference. To keep the range of depositional settings as broad as possible we would like participants to bring poster presentations of their own core-based sedimentological studies in addition to the core which will be provided. At this stage please let Martin Wells (Martin.Wells2@uk.bp.com), Boris Kostic (boriskostic@badley-ashton.co.uk) and Laura Griffiths (laura.griffiths@geosoc.org.uk) know if you would be interested in attending with (or without) a poster presentation so that we can assess numbers – likely maximum 40. This should also give you sufficient time to obtain the necessary permissions to share the material.

Call for Abstracts:
Please email paper and poster contributions to laura.griffiths@geosoc.org.uk and copy to Martin.Wells2@uk.bp.com by Friday 3rd October 2014

For further information please contact: Laura Griffiths
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Washington, DC, USA | 16-18 June 2014

Science Policy Event Set June 16-18

The registration deadline is fast approaching for AGU's annual Science Policy Conference, co-sponsored by AAPG, which brings together scientists, policy makers/shapers and community and industry leaders to discuss ways to communicate the complex issues of the science and engage in local and national policymaking.

The conference will be held June 16-18 in Washington, D.C. – but online

registration closes June 5.

Sessions will focus on the state of the science, policy activity and communication strategies relative to:

- ▶ Natural hazards.
- ▶ Climate change.
- ▶ Natural resource challenges.

The conference's first day also includes a hands-on science policy communications workshop for scientists.

To register or for more information, go to spc.agu.org.

Continued from previous page

the rapid local shifts in supply or demand – for example, California residential electricity costs are rising rapidly, partly in response to renewable electricity generation mandates and the closing of aging nuclear plants.

The Administration's 2014 Quadrennial Energy Review will focus on energy infrastructure. Its first benefit may be in providing more data about the complex interactions between energy systems that will aid business and regulatory decisions.

Exports

A slow process overseen by DOE and the Federal Energy Regulatory Commission regulates U.S. natural gas exports.

The first lower 48 LNG export terminal is expected to start operations in 2015. How much actually will be exported will depend on unpredictable global market forces, although applications for export permits now total almost 39 billion cubic feet (bcf) per day, about half of all U.S. production.


If this amount were actually exported – an unlikely event – the impact on U.S. and global markets would be severe.

Refined product exports generally are not regulated by the federal government, and have ballooned from about one million barrels per day in 2005 to 2.7 million barrels per day in 2013.

Witnesses at the May 1 hearing suggested that the reversal of the Cochin pipeline exacerbated this winter's Midwest propane shortage. The pipeline changed from a Canada-to-U.S. propane line to a north-flowing line exporting condensate to Canada.

The Ukraine unrest has revitalized the ongoing congressional debates about natural gas exports. Congressional views range between those wanting greater exports – to support energy needs of our allies and increase domestic employment – and those wanting to restrict exports, to keep consumer energy prices from rising.

For example, Rep. Cory Gardner (R-Colo.) introduced H.R. 6, the Domestic Prosperity and Global Freedom Act, which would expedite the approval of U.S. LNG export applications. From the opposite view, Rep. Edward Markey (D-Mass.) recently introduced H.R. 2088, the American Natural Gas Security and Consumer Protection Act, which would require the DOE to issue an environmental impact statement, including an analysis of the impacts of natural gas extraction on the local communities, before granting an export permit.

The final disclaimer of this column is that legislation rarely becomes law in the currently polarized Congress. 

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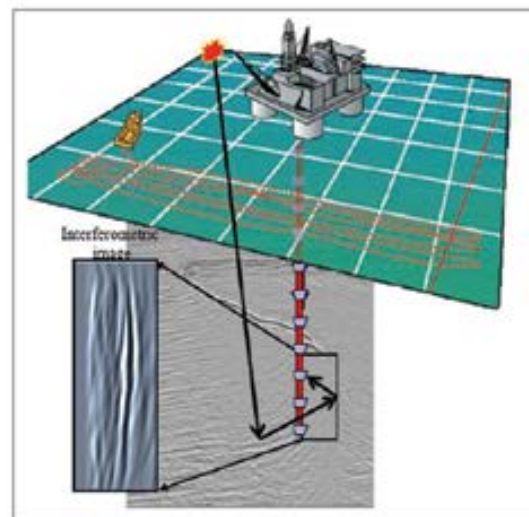
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Recent Advances with Well Whisperers

A seismic well whisperer is an earth scientist who can "magically" translate the borehole's seismic whispers into geological meaning. Such knowledge can then be used to coax the earth into yielding its oil and gas treasures.

Recent advances in downhole-receiver technology and imaging of VSP and passive recording data promise to greatly enhance the capabilities of seismic well whisperers. This special issue for Nov. 2015 will review some of these recent advances in borehole seismology and show how they greatly improve the interpreter's understanding of the reservoir.

- 1). Optical fiber technology promises an order of magnitude improvement in densely populating the well with receivers at lower cost.
- 2). Microseismic monitoring from wells.
- 3). Mirror imaging and interferometry increase the illumination area of the subsurface by more than an order of magnitude compared to conventional VSP imaging.
- 4). 3D spiral VSP surveys provide a cost-effective monitoring tool for the subsurface.
- 5). Full waveform inversion applied to VSP data provides higher resolution estimates of the velocity around the well.
- 6). VSP data provide natural Green's functions for migrating VSP and surface seismic data.



After Hornby and Yu, *The Leading Edge*, 2007, p. 760-763

Interpretation, copublished by SEG and AAPG, aims to advance the practice of subsurface interpretation.

The submissions will be processed according to the following timeline:

Submission deadline:
1 October 2014

Publication of issue:
August 2015

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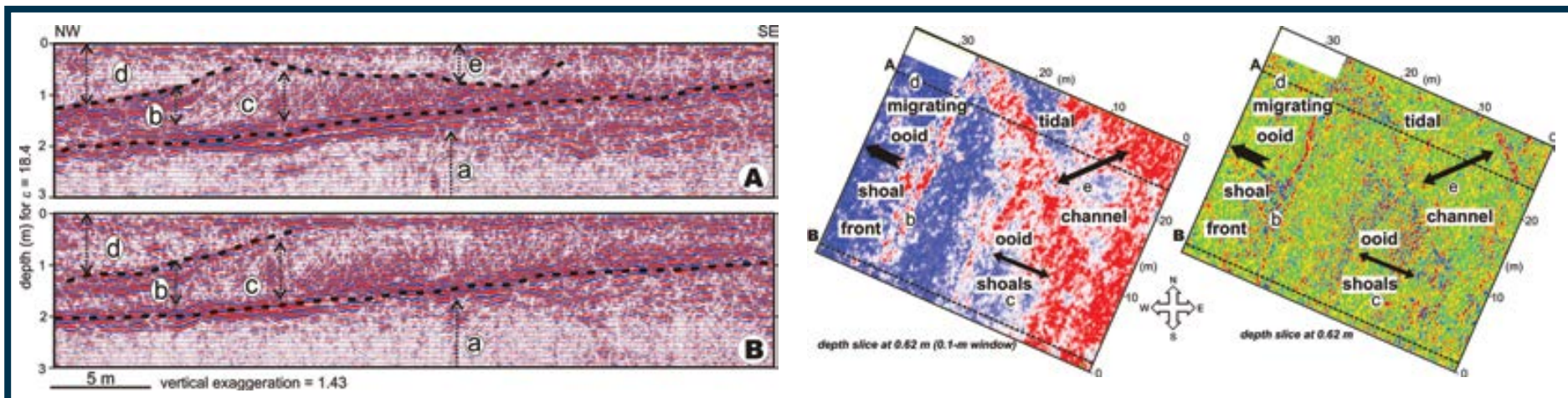


Figure 1—Left (a), 400-MHz GPR profiles from Andros Island. Letters indicate reflective domains referred to in the text and in figure 1b. Depth conversion was based on a dielectric constant of 18.4 (0.07 m/ns). This provides a vertical resolution of 4–5 centimeters. These and subsequent profiles were processed using software generously provided by a Landmark (Halliburton) university grant. Middle (b), depth slice averaged over 0.1 m depth from GPR 3-D volume in Andros with location of profiles A and B noted; right, same as middle, but with no vertical averaging, which provides enhanced precision.

Seeing Is Believing: GPR Enhances Analogs

By JOHN McBRIDE, COLBY HAZARD, SCOTT RITTER, THOMAS MORRIS, DAVID TINGEY, BILL KEACH, JANI RADEBAUGH, CLAYTON CHANDLER, KARL ARNOLD and GENE WOLFE

Steeply dipping bedforms and bed sets often develop where sediment accumulates and migrates, and are expressed as clinoform patterns on seismic data.

Ground-penetrating radar (GPR) provides ultra-high-resolution images of the internal structure of these sediment accumulations. Such images instruct the explorationist on the great complexity of these clinoforms and the potential for compartmentalization of a reservoir at fine scales.

Using GPR images of geologically recent sediments enables us to reconstruct the fine-scale process sedimentology, including changing current directions, bedform accumulation patterns and non-depositional and erosional events.

With this column we discuss GPR interpretations from two classic environments:

- ▶ The Pleistocene carbonate shelf of the south Florida-Caribbean region.
- ▶ The eolian linear dunes of the Namib Desert Sand Sea of west Africa.

The GPR data, recently acquired by teams of students and faculty from Brigham Young University, allow outcrop-scale interpretations of “seismic-like” waveform data that reveal what we might be missing in larger-scale seismic images of clinoform packages.

Carbonate Sediment Accumulations

The vast carbonate shallow-water platforms of the Bahamas represent one of the few laboratories where carbonate sedimentary processes can be studied in the modern realm, immediately adjacent to Pleistocene limestone formations preserved onshore.

Andros, the largest island of the Bahamas, is an ideal location for studying the internal structure of these deposits, where the accumulations of lime mud and ooid shoals have been integrated over long periods of geologic time.

A 400-MHz GPR survey on Andros was designed to target a single shallowing-upward depositional cycle, or parasequence (figure 1a). Interpretation of the five reflective domains is guided by modern analogs of carbonate sediments on the Great Bahama Bank that borders Andros.

Given this context, we interpret the

deep, poorly reflective interval (“a,” figure 1a) as low-energy, burrowed lime-mud lagoonal deposits with no expected internal bedding. The domain of low-angle clinoforms (domain “b”) is interpreted as a migrational front that prograded lagoonward over a stabilized tidal flat.

This accommodation space ultimately was filled with less-ordered and more heterogeneous lagoon-fill peloids, skeletal grains and mud (domain “d”).

The parallel (or sub-parallel) dipping reflector packages within domain “c” are interpreted as bankward-migrating ooid sand shoals that typically accumulate in shallow, high-energy tidal environments along the carbonate shelf margin.

Domain “e” is a muddier, less sandy deposit (confirmed by coring) interpreted to have accumulated in an abandoned tidal channel.

This interpretation also is supported by the depth-slice through domain (figure 1b), which cross-cuts both the underlying ooid shoal (“c”) and migrational front (“b”) facies.

Siliciclastic Eolian Dune Sediments

Linear sand dunes occur in large, low-latitude deserts in Namibia, the Sahara and the Arabian Peninsula. Winds blow oblique to the dune long axis, often with at least two different seasonal orientations that combine to transport sand parallel to the long axis.

The dunes are 0.5–2.0 kilometers in width, often reach hundreds of kilometers in length and can be up to 100 meters in height.

200-MHz GPR profiles acquired along the flanks of large linear dunes in the Namib Sand Sea captured well-expressed bedforms. We show one GPR profile (figure 2) that begins at the western base of a large linear dune, near the gravel of the interdune area, and continues up to the crest of the dune.

Two reflectivity intervals can be recognized:

- ▶ The upper interval consists of gently dipping planar reflectors that are well-layered and display a relatively uniform

character. This interval mantles (or drapes) a thicker and more complex interval of shorter, steeply dipping reflectors that are separated by internal bounding surfaces. This upper interval represents a large 2-D superimposed, flanking dune that is oriented perpendicular to the linear dune, but is migrating parallel to the linear dune (into the field of view).

- ▶ The lower interval displays two patterns.

✓ The bowl-shaped patterns are indicative of trough cross-stratification (TCS) produced by dunes with a 3-D wavefront moving approximately in and out of the cross section (i.e., parallel to the axis of the linear dune).

✓ Tabular to sigmoidal patterns indicate 2-D dune fronts migrating approximately along the cross section (i.e., perpendicular to the axis of the linear dune). These two patterns frequently

See GPR, page 47

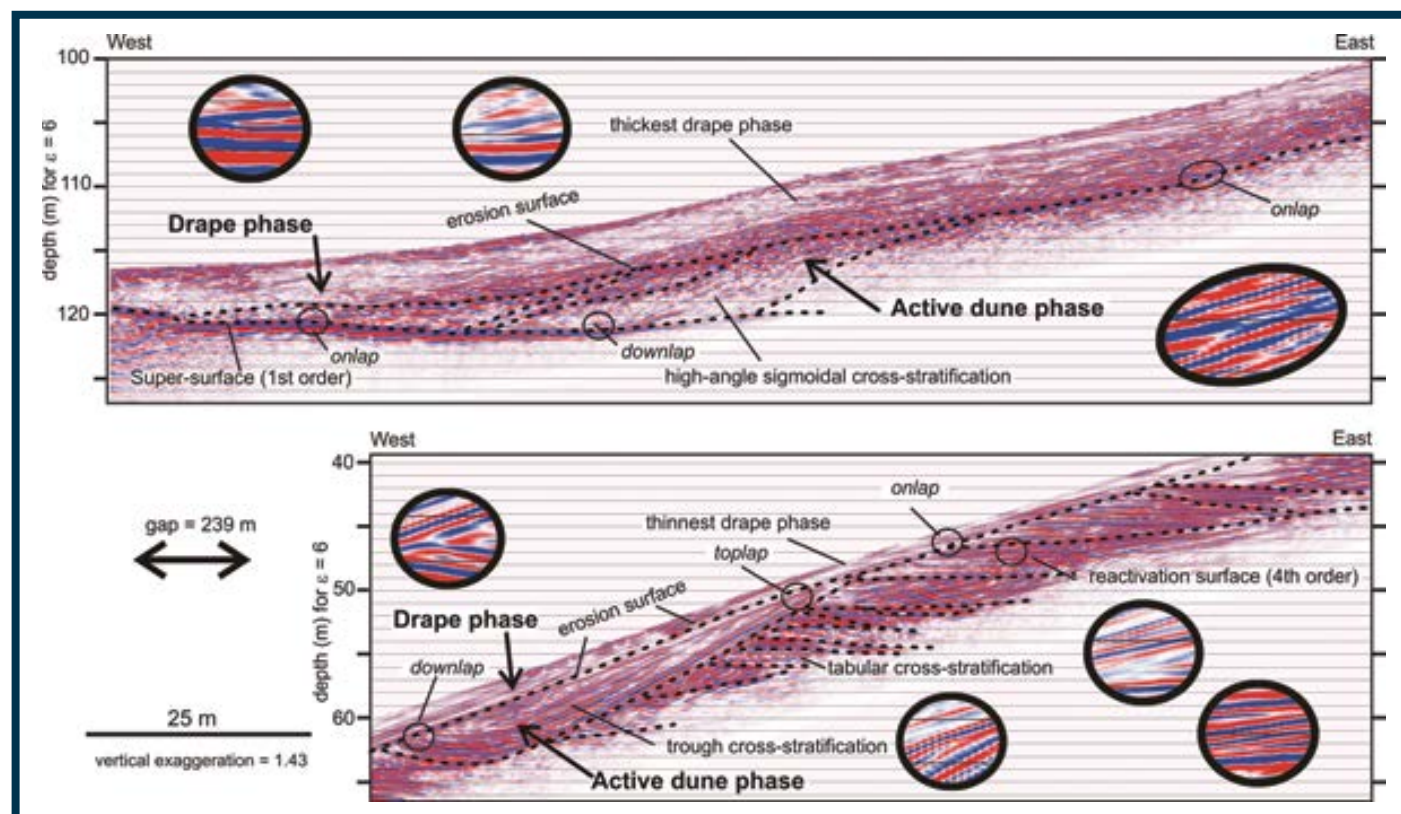
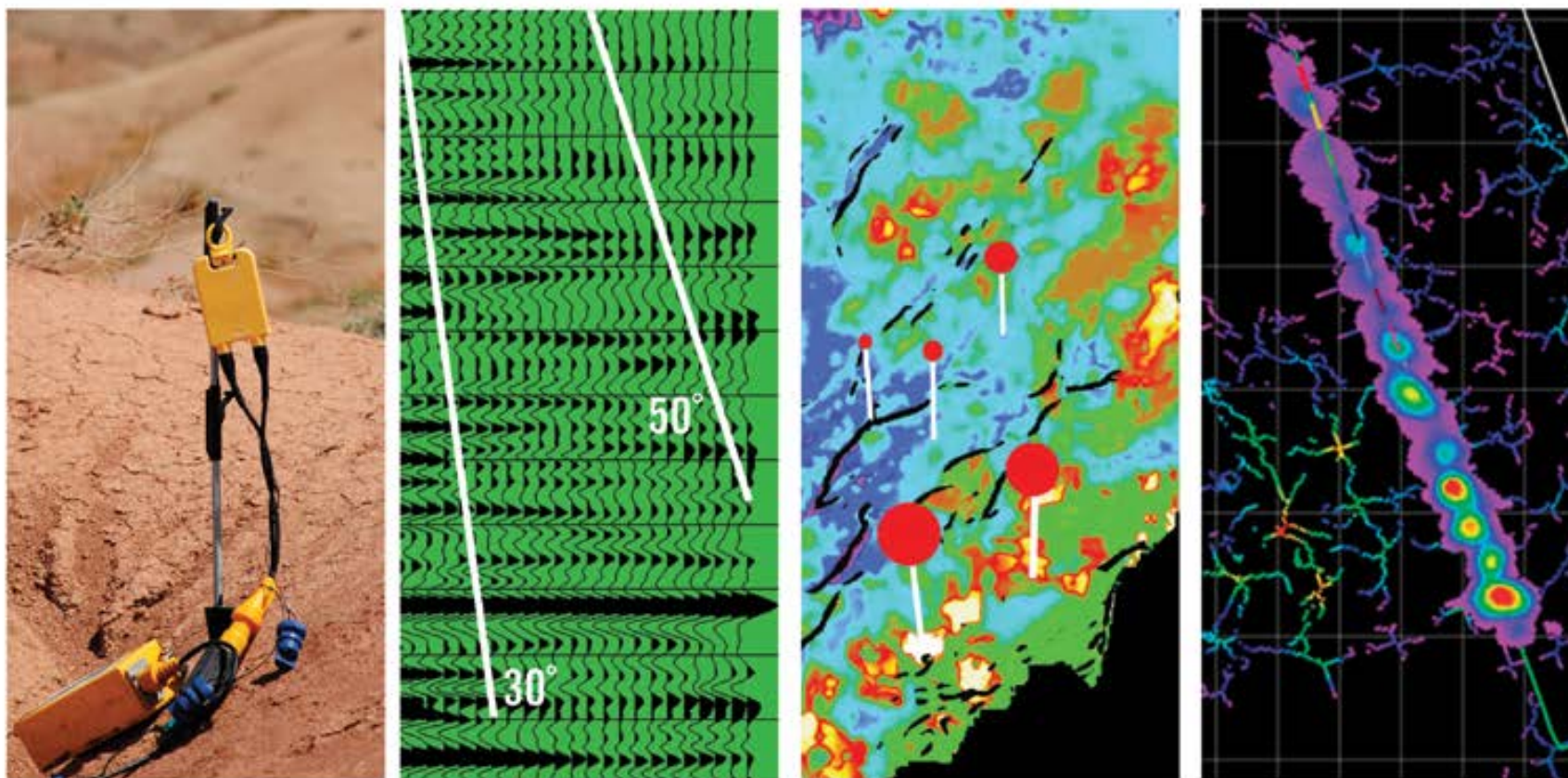


Figure 2—Excerpts of a 200-MHz GPR profile collected over the western flank of a dune in the Namib Desert. Excerpts of data are shown encircled. For depth conversion we used a dielectric constant of 6 (0.12 m/ns), yielding a vertical resolution of 15 centimeters. A dielectric constant of 6 is similar to values used previously for dunes in the Namib Desert and is consistent with a dry, quartz sand deposit.

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REGIONS and SECTIONS

Spanish field turns 50

Celebrating Ayoluengo

By JORGE NAVARRO

The Ayoluengo field, commonly cited as Spain's only onshore oil field, was discovered in June 1964. Today, 50 years later, the field is still active, with an average production of some 100 barrels oil per day and a total cumulated oil production of nearly 17 million barrels of oil.

This June marks the 50th anniversary of the discovery. The celebration's main sponsor is the municipality of the nearby village of Sargentos de la Lora (Burgos), along with several other groups, including the University of Burgos, Fundación Repsol and the AAPG-affiliated Spanish Association of Petroleum Geologists and Geophysicists (AGGEP).

A number of events are planned, including the inauguration of an oil museum in Sargentos de la Lora – the first of its kind in Spain.

The museum is planned to provide information about the oil industry and its products, focused mainly on the upstream, introducing the petroleum system concept and the wide variety of geological, geophysical and engineering techniques used on the E&P industry.

An important part of the exhibition is dedicated to the Ayoluengo field geology and its history, captured in an excellent collection of photos provided by the villagers and local newspapers, together with press clippings, documentaries of the mid-1960s, educative panels, geological 3-D models, drilling and production material and an authentic working rod pump.

The Big Boom

The Ayoluengo field is located about 300 kilometers north of Madrid, in the Basque-Cantabrian Basin, a geological region where natural oil seeps, tar and asphalts have been recognized since the early 20th century.

The region was considered highly promising and most of the hydrocarbon exploration effort in Spain during the 1940s and 1950s was focused in this area. Some basic underground mining was carried in the region during the 1940s to exploit the tar sands, but eventually abandoned because of poor economic results.

In the early 1960s, surface geological mapping and modern reflection seismic equipment allowed identification of a faulted anticline in an Upper Cretaceous carbonate flat plateau – an agricultural terrain mostly dedicated to growing potatoes – where the exploration well Ayoluengo-1 was located with the main objective of testing the Lower Jurassic carbonates at some 4,000 meters depth.

On June 6, 1964, the Ayoluengo-1 oil discovery well tested 85 barrels of oil per day from an unexpected, five-meter thick sandstone bed of Late Jurassic-Early Cretaceous age located at 1,350 meters depth. It was the first oil discovered in Spain after more than 100 exploration dry holes – and it brought great expectations in the region.

The oil discovery gained national attention, with extensive media coverage that helped attract many curious visitors to the wellsite. A "Texas Oil Boom in Spain" was a common headline.

The discovery also revitalized the

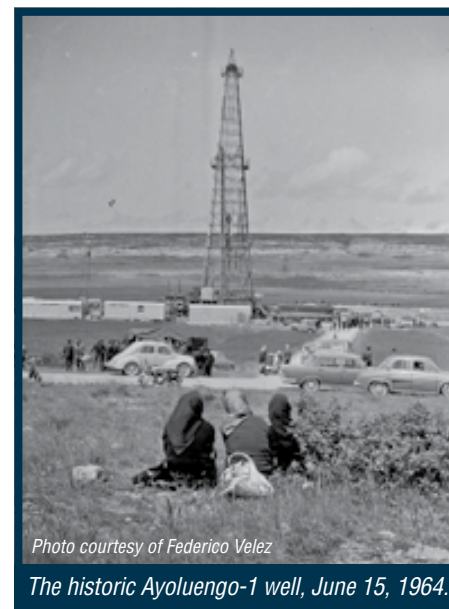


Photo courtesy of Federico Velez

The historic Ayoluengo-1 well, June 15, 1964.

seismic and drilling activity in the region, but subsequent exploration drilling only tested uncommercial oil flow rates.

Geologic History

Surprisingly, even after years of intense exploration activity, the Ayoluengo field remains Spain's only onshore commercial oil field – and also the only one in the entire Iberian Peninsula.

This anomalous geological singularity has brought recurrent discussions among petroleum geologists, all trying to explain why it is the only one within a vast territory.

The Ayoluengo field consists of a NE-SW-oriented and fractured anticline with a series of thin lenticular sandstones packages of Late Jurassic-Early Cretaceous age. More than 50 separated oil and gas sandstone beds have been identified. Some are as thick as 10 meters, but the average is only two-three meters.

Areal extent of these lenticular sandstone bodies varies widely. Some are quite restricted, while others are laterally continuous. The sandstones have mean porosity values of 18 percent and permeability up to 1 Darcy.

Most of the individual reservoir layers are isolated by shales and compartmentalized by faults; thus, Ayoluengo is considered to be not a single field but the grouping of more than 100 independent small fields.

The organic-rich marls and black shales of Liassic age have been largely considered as the only source of the oil, but this is still far from clear. The deep erosion by rivers in nearby areas allows observation on outcrops of most of the elements of the Ayoluengo petroleum system: tar impregnated sandstones, the claimed Liassic source rock and text-book faulted anticlines.

The first Ayoluengo oil production started in 1967, reaching peak production at 5,200 barrels of oil per day in 1969 before gradually declining. Oil is produced by rod pumps, locally and popularly known in Spanish as "caballitos." The small amount of produced natural gas is used to power the rod pumps motors and to generate the electricity used in the field.

A total of 52 wells have been drilled in the field, the last one in 1990. Currently only 10 wells are active.

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Permian and Midland Basin New Technologies RX

Sept. 4-5, 2014 – Houston

This two-day event is an exchange of new and emerging technologies and techniques that are needed to optimize operations in existing and expanded plays in the Permian and Midland. Learners will learn new workflows and technologies to integrate petrophysical, geochemical, seismic, biostratigraphic and geomechanical information for reservoir optimization. Presentations will review new stacked pays and effective approaches in secondary and tertiary recovery, with a focus on the geological information to design and implement new waterfloods, CO₂ floods and other types of enhanced recovery technologies.

www.aapg.org/career/training/in-person/forums

GPR
from page 44

cross-cut each other, indicating active migration of superimposed dunes on the flank of the dune during this phase of deposition.

Although the GPR profile displays multiple migration directions for these superimposed dunes, the abundance of bowl-shaped TCS sets suggests a strong component of axis-parallel dune migration.

The most prominent single reflector on the profile separates the upper and lower intervals – this surface displays a variety of reflection terminations including tolap, downlap and onlap (figure 2). These terminations suggest that the reflector was a prominent erosional surface.

This surface thus delineates a major change in process sedimentology from an active dune migration phase below to a sediment-draping phase above. The various stratigraphic phases undoubtedly represent variable wind flow regimes over time as well as the evolving geometry of the linear dune as it grows and migrates.

Giant Foresets Formation, Taranaki Basin

Remember that the foregoing observations from GPR are at scales well beneath “sub-seismic.” Let’s now consider a conventional seismic example on which analogous clinof orm features are expressed.

The Giant Foresets Formation is a Plio-Pleistocene succession of fine-grained clastic sediments deposited on the marine shelf-to-basin margin of the northern Taranaki Basin, located offshore northwest of New Zealand. This formation is known for its well-expressed stacked, sigmoidal wedges of clinof orm reflectors, and it contains topset, progradational or degradational foreset and bottomset reflectors (figure 3).

These reflector patterns represent different facies on the continental shelf, slope and basin floor, respectively.

Qualitatively, the patterns are similar to those on the GPR sections and likewise represent variations in the energy of the environment, depositional slope and wind or wave direction.


* * *

Lessons for the seismic interpreter learned from the GPR examples:

▶ Progradational and bedset patterns are scale-invariant on waveform data.

▶ Although the depositional environments in these examples are fundamentally different, clinof orm reflectivity patterns have much in common.

▶ Thus, much can be learned from studying fine-scale geological analogs using GPR.

▶ GPR data show how “hidden” fine-scale heterogeneity in sediment packages could affect flow and storage compartmentalization in a reservoir. 

(Editor’s note: Lead author John McBride and all other authors but Gene Wolfe are with the Department of Geological Sciences at Brigham Young University, Provo, Utah. Wolfe is with Halliburton Software and Asset Solutions, Highlands Ranch, Colo.)

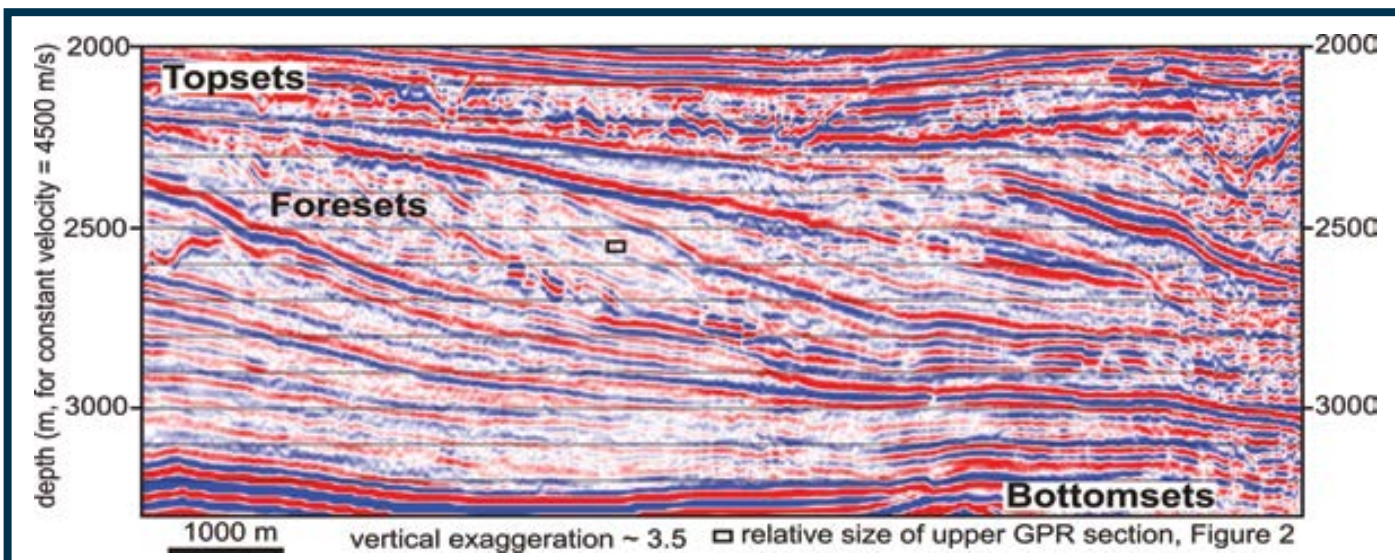



Figure 3 – Excerpt from the 3-D Parihaka seismic dataset, Taranaki Basin, showing an example of the Giant Foreset Formation. For an assumed generalized velocity of 4500 m/s and an assumed dominant frequency of 50 Hz, the vertical resolution of the data is about 23 meters. Data set courtesy of Gerald A. Morton and Pogo Producing Company (now Plains Exploration and Production Company).



AAPG

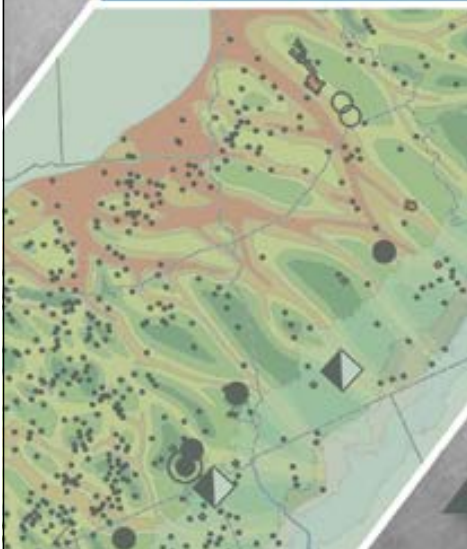
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Submit your abstracts online ACE.AAPG.org Deadline: 2 October

YPs Draw Texas-Sized Crowd at Houston ACE

By MEREDITH FABER and NICK LAGRILLIÈRE

“Everything is bigger in Texas” might be a tired adage, but it definitely rang true at the AAPG Annual Convention and Exhibition (ACE) in Houston in April. With an unprecedented number of abstract submissions and attendance ranked as the third largest in AAPG history, Space City’s thirteenth time as host city proved far from unlucky.

Fortunately, a bit of that luck rubbed off on the Young Professionals (YPs) whose signature activities, the YP Meet and Greet and the YP Networking Reception, attracted their largest crowds to date.

▶ The YP Meet and Greet, which was held on Sunday afternoon and sponsored by Noble Energy, attracted over 350 students, YPs and mentors.

As in past years, the group gathered to network, discuss careers in the oil and gas industry and the benefits of continued membership in AAPG – and enjoy refreshments.

After an hour of mixing and mingling, mentors were encouraged to accompany the student and YP participants to the Imperial Barrel Award ceremony and the opening session.

▶ Following the Icebreaker, over 250 YPs gathered at The Grove in downtown Houston for the **YP Networking Reception**, also sponsored by Noble Energy. Attendees enjoyed good food, local beer and the chance to network with other YPs attending the ACE.



FABER



LAGRILLIÈRE

The “invitation-only” gathering gave YPs another chance to share experiences with

each other about working in the industry and being a part of AAPG.

Also during the event, a special presentation was made to outgoing YP Committee chair Nick Lagrillière, who received a leadership award in appreciation of his achievements leading the committee, his dedication to progressing YP initiatives and his years of service to the Association.

Overall, the YP events at ACE were a big hit and their success and popularity were in large part thanks to the generous

sponsorship of Noble Energy, which was represented at this year’s events by AAPG members Henry Pettingill and Chuck Caughey.

The YP Committee would like to thank everyone who participated in this year’s activities. We look forward to repeating the experience at next year’s ACE in Denver.

Stay tuned for details! ☰

(Editor’s note: Meredith Faber is vice chair and Nick Lagrillière is chair of AAPG’s Young Professionals Committee.)

Technical Program Set, Registration Opens for ICE

The technical program has been finalized and registration is open for this year’s AAPG International Conference and Exhibition (ICE), set Sept. 14-17 in Istanbul, Turkey.

The theme for the meeting – hosted by the Turkish Association of Petroleum Geologists and the AAPG European and Middle East Regions – is “The Spirit Between Continents: Energy Geosciences in a Changing World.”

Organizers said the technical program will provide the latest in science – not only for regional plays, but also geological advances from around the world.

The technical program themes include:

- ▶ New and Emerging E&P Provinces.
- ▶ E&P in Mature Basins.
- ▶ Regional Geology and Tectonics.

- ▶ G&G Integration.
- ▶ Unconventional Resources.
- ▶ Conventional Resources.
- ▶ Petroleum Systems and Geochemistry.
- ▶ Siliciclastics and Carbonates.
- ▶ Structural Geology and Traps.
- ▶ Health, Safety, Environment Geology and Hydrogeology.
- ▶ History of Petroleum Geology.

Several special forums are planned, including:

- ▶ Technical Innovation and Collaboration – Keys to Affordable Energy.
- ▶ Tethys Evolution.
- ▶ Sessions honoring the careers and work of AAPG legendary geologists Peter Ziegler and Dave Roberts.
- ▶ The newest presentation of the Discovery Thinking Forum, this time offering

specific talks on northern Iraq, India’s Barmer Basin, Yemen’s Habbaniya Field and Oman’s Mabrouk deep gas discovery.

This year’s event marks the first time an ICE has been held in Istanbul, but the meeting has other historical significance: For the first time, an ICE will incorporate AAPG’s regional Prospect and Property Expo (APPEX), which will offer its own exploration-themed presentations and exhibits alongside those of ICE.

APPEX is the key forum for networking and international deal development, carefully designed for participants to meet, discuss and negotiate deals with global decision makers.

Complete ICE details and registration information can be found online at ice.aapg.org/2014. ☰

SAVE THE DATE

Unconventionals Update GTW

Nov. 4-5, 2014 – Austin, Texas

Join us to learn the latest technologies being successfully applied in the main unconventional plays, and how the knowledge can be applied to other plays. Geochemical methods, integrated 3D seismic, fracture characterization, and more are used to identify sweet spots. Participants will also learn about the latest infill drilling, increased density (and issues of fracture interference), stacked pay development, proppant and fluid selection (avoiding formation damage), reservoir characterization while drilling, workflows and decision-making.

Bakken Three Forks / Mancos Shale GTW

Nov. 17-19, 2014 – Golden, Colorado

Participants will learn how to be successful in utilizing the Three Forks in a stacked-pay, pad-drilling strategy and also when pursuing this Bakken member separately. Attendees will learn how to apply 3D seismic and seismic attributes, use geochemistry and geochemical information to map sweet spots and to predict fracture behavior (including fluid behavior in the fractures, including fracture interference in increased density infill drilling of laterals).



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Setting the record straight

Gas Leaks, Revisited

By KEN MILAM, EXPLORER Correspondent

Some surprising findings bubbled up in a recent study of methane geochemistry in the Appalachian Basin.



BALDASSARE

The findings could complicate the jobs of investigators trying to determine how stray methane gets into water wells.

"Our results should be of value to all O&G companies that operate in the Appalachian Basin as well as any environmental professionals that are involved in characterizing or understanding incidents of stray gas migration," said Fred Baldassare of Echelon Applied Geochemistry Consulting, lead author of the paper published in the February AAPG BULLETIN.

Previous investigators thought that methane occurring naturally in water supplies was biogenic, and if early thermogenic gas turned up, it must be the result of migration from natural gas wells.

Baldassare and his co-authors, Mark A. McCafferty of Weatherford Laboratories and AAPG member John A. Harper of the Pennsylvania Geological Survey, used what they say is the largest published geochemistry database in the Appalachian basin and found otherwise.

"This interpretation that post mature gas in the aquifer system is evidence of gas migration from the Marcellus is flawed," Baldassare said.

"Our dataset (more than 2,200 samples) reveals (that) thermogenic gas that is also post mature thermogenic and genetically similar in origin to gas that occurs in the Marcellus also occurs in formations above the Marcellus," Baldassare said, "including the Hamilton Group, Tully Limestone and Genesee Shale."

Most of the data used for the study that was first revealed in the AAPG BULLETIN was collected during the drilling process for 234 Marcellus gas wells throughout a five-county study area.

The sampling protocol, Baldassare said, "was developed to define the different gas types that occur in the stratigraphy in the vertical section of the well and in the Marcellus Formation."

Mischaracterized Research?

To Baldassare and his co-authors, a stray gas migration incident in 2009 in Dimock, Pa., ostensibly was ground zero for stray gas migration incidents associated with the shale gas industry.

"The incident was often misrepresented by the media, and further mischaracterized by research that, in my view, was rushed to publication," Baldassare said.

"Since then, the O&G industry has been under the microscope," he added. "It has been reported by a small group of researchers based on a small dataset (less than 160 samples) that gas from the Marcellus (post mature thermogenic in origin) has been found in the aquifer system in some of the areas where stray gas incidents have occurred."

"The implication of an allegation that gas from the Marcellus has contaminated the aquifer system is that the process of hydraulic fracturing is the mechanism responsible for the stray gas migration," he added.

Baldassare said investigations must be site-specific, and that the new findings "should only be used as a general guide."

"We go to great lengths to advise the reader that proper interpretation of gas geochemistry is fundamentally important to the investigation," he said, "however, other site specific data is necessary to conclude the source(s) of stray gas."

Nonetheless, "Our results should be of value to all O&G companies that operate in the Appalachian Basin as well as any environmental professionals that are involved in characterizing or understanding incidents of stray gas migration," he said.

"They represent a proven approach that should be useful to define pre-existing conditions in basins around the world." ■

URTeC Registration Savings Offered

Online registration continues for the second annual Unconventional Resources Technology (URTeC) Conference, which will be held Aug. 25-27 at the Colorado Convention Center in Denver.

Attendees can save up to \$100 on fees if they register by July 14.

URTeC, hosted jointly by AAPG, the Society of Petroleum Engineers (SPE) and the Society of Exploration Geophysicists (SEG), is the industry's only integrated event for unconventional resource teams.

"It's the only conference where the three big professional societies come together," said AAPG Honorary member Randy Ray of R3 Exploration Corp., who also co-chairs the URTeC technical program committee as a representative of SEG.

His co-chairs on the committee are Honorary member and past AAPG president Steve Sonnenberg of the

Colorado School of Mines, representing AAPG, and AAPG Associate member Luis Baez of BG Group, representing SPE.

The technical program boasts papers from all three disciplines dealing with innovations, best practices and experiences in integrated approaches for North American unconventional resource plays.

Ray said this year's technical program will differ from last year's in that the sessions are organized to serve a more integrated audience, whereas they were more discipline-specific in 2013.

"We are intentionally trying to have technical sessions in which we have an engineer and a geologist and a geophysicist give presentations within that same technical theme," he said.

For more information go to the URTeC website, at www.urtec.org. ■

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This event will take place in Atyrau city, the oil capital of Kazakhstan, on May 26-27, 2015. The Conference is organized by the Association of Petroleum Geologists of Kazakhstan (APGK).

For detailed information please address to: Tatyana Tomachkova, APGK Executive Director, e-mail: info@ongk.kz. Please, visit website www.ongk.kz, or call us by phone: +7 (7122) 30-41-28, fax: +7 (7122) 27-13-69.

'Helping Students to Think' Is His Passion

By BARRY FRIEDMAN, EXPLORER Correspondent

After the interview, the emails back and forth, the attachments of background material about his teaching and research, Robert H. Goldstein, this year's AAPG Foundation Professorial Award recipient, had a special request.

"Is there some way," he wrote in an email during a weekend correspondence, where we both chided each other about actually working on the weekend, "I can have a quote that expresses appreciation to the students who nominated me and to my colleague, Evan Franseen, who wrote a letter in support of this?"

Which should tell you all you need to know about why such a man would receive such an award.

This is a gracious, humble man, and someone who loves what he does.

Goldstein, an associate dean and Haas Distinguished Professor in the Department of Geology at the University of Kansas – he's been there for 29 years, helping to build the school's geosciences programs to a place of national prominence – said there's something special about the make-up of this particular award.

"This honor is even more meaningful because it comes from AAPG," Goldstein said, "an organization that truly represents my interests and those of the students I teach."

A carbonate sedimentologist by training, Goldstein, who has supervised or co-supervised more than 40 graduate



GOLDSTEIN

"I very much enjoy the challenge ... to help students develop a deeper background understanding, so they can rapidly take the next steps in solving a problem."

students, said that teaching – whether it's to engineers, geologists or geophysicists – goes far beyond the particular discipline.

"For me," he said, "teaching in the geosciences is incredibly rewarding work."

'Ah Ha'

Goldstein is the third recipient of the Foundation's Professorial Award, given to a college or university professor who has demonstrated outstanding leadership in the field of geoscience education.

The first two recipients were James Evans, of the Utah State University College of Science, and Grant Wach, of Dalhousie University in Halifax, Canada.

Award recipients receive a \$1,000 prize from the AAPG Foundation plus a commemorative plaque acknowledging the achievement.

One gets the feeling the prize itself is a secondary bonus for Goldstein.

"I truly love teaching at all levels, from

Introduction to Geology to AAPG field seminars," he said. "For me, teaching in the geosciences is all about helping students to think and see."

Goldstein said that his goal – and you get the sense he thinks it should be the goal for everyone who teaches – is to provide a way for a student to have, what he calls, an "Ah ha" moment.

A moment when they realize: This is how science works.

One of the ways in which he does that, personally, is by engaging his students at all times – classroom, lab, field trips – in specific geologic problems.

"That inevitably leads to interactions where the students want to dig deeper, or need some background skills to move further in solving the problem," he said.

In fact, it was his colleague Franseen who said that Goldstein can lecture at a moment's notice, a notion Goldstein thinks is a prerequisite for teachers, and for good reason.

"Students ask questions all the time," he said.

"I very much enjoy the challenge of offering concise and organized instruction to them on demand and at the drop of a hat, to help students develop a deeper background understanding, so they can rapidly take the next steps in solving a problem.

"Typically, those explanations or mini-lectures stick out in students' memories," he continued. "They seem to sink in, as students have learned the new skill or concept in the context of solving an engaging problem they are already working on."

STEM the Tide

Goldstein, who has won teaching awards at the University of Kansas at the introductory, undergraduate and graduate levels, is perhaps uniquely qualified to discuss the state of geoscience education in not just Lawrence, Kansas, but America.

"As most are well aware, there is currently a huge challenge in STEM higher education (the study of science, technology, technology and mathematics) and that has a big impact on our workforce," which, he adds, is a problem, for in high school most students do not get a strong background in the geosciences.

The result: "Few are initially interested in our discipline when they first get to

See Goldstein, page 52



Military Veterans Scholarship Program Primed for Action – But We Need YOU!

Thanks to our many generous supporters, the Foundation is fast approaching a \$500,000 threshold established to launch our new Military Veterans Scholarship Program.

We have crested the \$400,000 mark and need to raise \$100,000 more so that we may initiate the program. But that's just the start. The more we raise for the fund, the more scholarships we can provide to U.S. veterans who want to be part of today's geosciences profession.

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**- Chris Villarreal
Captain, U.S. Army Infantry**



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Potential from page 40


Mexico's petroleum potential includes unconventional oil and gas and resources distributed in diverse regions of the country.

Systematic studies have been carried out in the last five years with several exploration wells drilled in order to determine tight oil and shale gas potential, which has been identified in Veracruz, Chihuahua, Sabinas-Burro-Picachos, Burgos, and Tampico-Misantla. The unconventional hydrocarbon resources are principally associated with the Eagle Ford formation of Cretaceous age as it extends from south Texas into northern Mexico, the late Jurassic Pimienta formation in the northern and eastern part of the country.

Resources in Paleozoic and Cretaceous hydrocarbon rich rocks are also being investigated. Pemex estimates its unconventional resources at a mean of 141 TCF and 32 BBO (figure 2) – potentially the world's fourth largest unconventional reserve.

The development of these resources could triple gas production to 20 bcf per day, contributing to fully satisfy the national energy needs and promoting a robust growth of the petrochemical industry.

The rich endowment of the country's oil production declined from 3.4 mmobd in 2004 to 2.5 mmobd today, regardless of increased investments (figure 3), which together with the constant reduction of the reserves led the government to reconsider its long-term policy of having Pemex as the country's sole E&P operator and make constitutional changes that now allow third-party participation in the upstream sector.

Previously in 2008, the Mexican Congress had approved a series of energy measures that would allow Pemex to bring in foreign and private companies in order to carry on E&P activities based on service contracts, however these reforms were so slight that they did not manage to attract the interest of international operating companies. 



UPCOMING DEADLINES

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| Geophysical imaging and interpretation of outcrops | 30 August 2014 |

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Interpretation, copublished by SEG and AAPG, aims to advance the practice of subsurface interpretation.

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Goldstein from page 50

college," he said.

Since 2011 Goldstein has been in charge of developing and administering new programs at KU to help improve teaching and learning for students in these STEM disciplines.

In addition, he said, too many students who are initially interested in STEM fields in high school migrate away from STEM once they get to college.


"At colleges and universities, we must both attract students to our field and keep those interested in the geosciences highly engaged," he said, which means that the curriculum has to get students in the field as much as possible, working on problem solving and getting away from what he calls "sage-on-a-stage" large lecture styles of classes, so common in many colleges and universities.

To this end, Goldstein is part of the Bay View Alliance, a network of U.S. and Canadian research universities taking a leadership role – much like he's doing at KU – for increasing the adoption of improved teaching methods at colleges and universities in North America.

At the moment, one of his roles is leading the design and fundraising for an \$86 million Earth, Energy and Environment Center at KU that will integrate the school's energy, environment and industry outreach programs, including fossil fuel, geology, geophysics, organic geochemistry, nanoscience, groundwater hydrogeology and other related programs.

For this "sage-on-a stage," Goldstein's work, his life and his hobbies are all co-mingled.

"My personal life tends to involve a lot of travel," he said. "This revolves around my roles as a faculty member in geology, researcher in carbonates, associate dean for natural sciences and mathematics, as well as my outreach and training role for industry.

"Luckily," he added, "my wife, Cindy, enjoys this travel as much as I do, and she is my partner for most of these trips." 

DEG
from page 54

can be construed as negative, neutral or positive, depending on which definitions you choose.

For the DEG, we do not want to be thought of as negative, or even neutral, but as a positive force for good within the AAPG, our industry and globally.

As a "division," not separated from but a part of, included in the whole.

As "environmental," the aggregate of social, cultural and ecological

factors that surround us all as related to global fossil fuel production and as "geosciences," using the skills and knowledge we have as geologists, geophysicists and geochemists to make it all happen.

The small word "of" then becomes the binding relationship that we all have between our industry, the environment and ourselves.

* * *

It has been my honor, privilege and pleasure to be your DEG president for this past year! ☑

CLASSIFIED ADS

POSITION AVAILABLE

**DIRECTOR
OKLAHOMA GEOLOGICAL SURVEY
UNIVERSITY OF OKLAHOMA**

Applications are being solicited for the position of Director, Oklahoma Geological Survey (OGS). The OGS is located on the University of Oklahoma campus in Norman, Oklahoma, and is under the direction and supervision of the Board of Regents of the University of Oklahoma. Organizationally, the OGS is located within the Mewbourne College of Earth & Energy, which also includes the ConocoPhillips School of Geology & Geophysics and the Mewbourne School of Petroleum & Geological Engineering. The Director of the OGS reports administratively to the Dean, Mewbourne College of Earth & Energy. If appropriate, the successful candidate may hold a dual appointment as a faculty member within the College as an Associate or Full Professor, renewable term or tenured. Candidates should hold a doctorate in geology, geophysics or a closely related field.

Prior experience with a public agency would be beneficial. The objectives and duties of the Oklahoma Geological Survey include the following:

(a) A study of the geological formations of the state with special reference to its natural resources, including coal, oil, gas, asphalt, gypsum, salt, cement, stone, clay, lead, zinc, iron, sand, road building material, water resources and all other mineral resources.

(b) Management of the Oklahoma seismic recording network, and the reporting and analysis of earthquake activity in the state.

(c) The preparation and publication of bulletins and reports, accompanied with necessary illustrations and maps, including both general and detailed descriptions of the geological structure and mineral resources of the state.

(d) The consideration of such other related scientific and economic questions that shall be deemed of value to the people of Oklahoma.

The Director of the OGS has the responsibility of overseeing activities related to geological and geophysical studies of Oklahoma and adjacent areas, preparation of reports documenting the findings of these studies, and communication of these results to individuals, agencies and the general public as appropriate and/or required.

The position requires supervision and administration of an organization of approximately 50 staff and associated facilities including offices, labs and the Oklahoma Petroleum Information Center (OPIC), which contains an extensive collection of rock cores and samples, other well information and selected facilities for the examination of these cores and samples. It is anticipated that the Director of the OGS will work with Oklahoma universities, state and federal agencies, industry and other entities to conduct research in areas of public interest, as well as providing advice and service in the areas of geology, geophysics and natural resources. One particular area of current high interest is the recent, significant increase in Oklahoma earthquake activity.

The successful candidate will have the demonstrated experience and ability to oversee these activities, while acting as the State Geologist of Oklahoma. Areas of experience that could be considered include an appropriate background with state or national surveys, administration in academia, experience in industry or research, or other related areas. Review of candidates will begin June 1, 2014 and continue until the position is filled. The anticipated starting date is January 1, 2015.

Applicants are requested to submit a complete resume, statement of relevant experience and a list

of five references who can be contacted, including names, phone numbers, email addresses and complete mailing addresses. Questions or requests for additional information may be addressed to:

Larry R. Grillot,
Dean of the Mewbourne College of Earth & Energy, and Chair of the OGS Director Search Committee, at (405) 325-3821, or lrgillot@ou.edu. Applications and nominations should be addressed to OGS Director Search Committee, University of Oklahoma, Sarkeys Energy Center, 100 East Boyd Street, Room 1510, Norman, OK 73019-1008.

The University of Oklahoma is an Affirmative Action, Equal Opportunity Employer. Women, minorities, protected veterans and individuals with disabilities are encouraged to apply.

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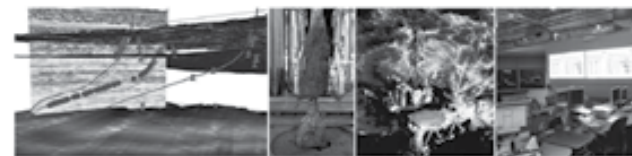
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26-27 November, 2014

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Following the highly successful Operations Geology Workshop held in Aberdeen in October 2012, the Petroleum Group of the Geological Society are pleased to announce the dates for the next event, which will be held over two days in 2014. Operations Geologists play key integrating roles at all stages of the life cycle of a well. This conference will look at the life cycle of a well and the contributions of Operations Geology at each stage:

- **Well Planning** - hazard identification (due to rocks, fabric, pressure, stress, geometry etc) and avoidance/mitigation, targeted data acquisition for all disciplines for life of field
- **Execution** - real-time techniques, managing the drilling window, the acquisition and use of integrity test data, appropriate isolation of permeable zones in the overburden
- **After Action Review** - NPT analysis and the learning loop, continuous improvement
- **Emerging Technologies** - the next generation of needs and solutions - logging, formation and gas detection/analysis, real-time well bore stability analysis tools, PPFG tools
- **Professional Competence** - the need to strengthen the available processes

CONFIRMED KEYNOTE SPEAKERS:

Malcolm Brown, BG Group
Iain Stewart, University of Plymouth

Conference Dinner

Registration is now open for the Conference Dinner to be held on Wednesday 26th November at the Cavendish Hotel, Jermyn Street

For further information, please contact Laura Griffiths, Event Co-ordinator;
+44 (0)20 7432 0983 or E-mail: laura.griffiths@geolsoc.org.uk
www.geolsoc.org.uk/Operations-Geology-Conference



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Today's Shale Boom: Nothing Invisible About This Story

By DAVID CURTISS

Shale continues to dominate the headlines. Seemingly everywhere I look there is a new cover story or feature article on the "energy renaissance" or "shale revolution" that is transforming global oil and gas markets and handing the United States a sizable geopolitical advantage. Back-to-back issues of the journal *Foreign Affairs* have covered the subject, and it's also been featured recently in a special section of *Petroleum Economist*.

For those of us in and around the oil and gas industry there isn't a lot of new information in these articles. And while I gain new perspectives as I read these noted experts in foreign affairs and economics, they don't represent the full picture.

Robert Blackhill of the Council on Foreign Relations and Meghan O'Sullivan of Harvard University's Kennedy School of Government write expansively in the March/April edition of *Foreign Affairs* of the "geopolitical consequences of the shale revolution."

Their thesis is that new U.S. crude supplies flowing into global markets may well lower prices, thereby limiting the influence (and coffers) of major producers, shifting the balance of energy power and conferring the benefits of those lower prices to consumer nations.

"Ever since 1971, when U.S. oil production peaked, energy has been construed as a strategic liability for the country, with its ever-growing thirst for reasonably priced fossil fuels sometimes necessitating incongruous alliances and complex obligations abroad," they write. "But that logic has been upended, and the newly unlocked energy is set to boost



CURTISS

It was the result of having a system in place that rewards initiative and encourages individuals to put capital at risk in the pursuit of economic gains.

the U.S. economy and grant Washington newfound leverage around the world." Well, maybe.

* * *

The cover of the May/June *Foreign Affairs* features a dark fractured rock surface with orange flames shooting out of the fissures and the title, "Big Fracking Deal: Shale and the Future of Energy."

In this issue the head of Citi's global commodities research, Edward Morse, extols the virtues of shale both for the United States and the globe, seeing production increasing, production costs decreasing and overall prices declining to deliver a boon to energy consumers.

Outside the United States, he says, "there is no longer any doubt about the sheer abundance of this new accessible resource base ..."

One reason I believe the policy and economics community is talking about this now is because the trends are observable: U.S. natural gas production, for example, has steadily risen – up 25 percent since 2010, observes Morse. Permits to authorize U.S. LNG exports are dribbling out – slowly, but they are being issued.

These trends are frequently presented

as both inevitable and persistent. And innovation and technological advancements are said to easily sweep away any obstacles in our path to realizing the potential of this energy renaissance.

I'm reminded of Adam Smith's "Invisible Hand" guiding and directing the markets. And that makes me uneasy, because it does not reflect the daily concerns I hear about as I talk to our members: the challenges of escalating costs, hydraulic fracturing programs that don't perform as expected and the continual pressure to replace reserves.

And that is what makes the essay in the same issue of *Foreign Affairs* by AAPG member Robert A. Hefner III so welcome.

A decade ago U.S. oil and gas production was a shadow of what it is today; certainly no one was talking about a renaissance or revolution. And as Hefner explains, the story of shale is a story of the triumph of the little guy – the small independent oil and gas operator who had the fortune to be operating in the United States.

He correctly observes that the success of shale production in the United States is the result of several factors, including:

- ▶ Favorable geology.
- ▶ Innovative thinking and ideas.

- ▶ Demand for the product.
- ▶ An entrepreneurial culture among independent operators.
- ▶ Property rights that give both producers and mineral rights owners incentive to find and produce these resources.

Pursuing shale resources in the United States was not the result of a policy decision. It was the result of having a system in place that rewards initiative and encourages individuals to put capital at risk in the pursuit of economic gains.

In fact, Hefner warns politicians against tinkering with a system that is already working.

* * *

The folks in capitals across this globe listen to and rely on experts, such as those writing in *Foreign Affairs* and similar publications. They're smart and have important perspectives to share. But they need our help to understand the realities beneath the trends that they are measuring and reporting.

Shale is transforming the energy sector, bringing new oil and natural gas to consumers worldwide.

But it wasn't an invisible hand that found those resources and produced them. It was a hand swinging a rock hammer, a hand connected to a brain interpreting a well log or seismic section, and a hand gripping a pipe wrench operating in a system that rewarded that activity.

DIVISIONS REPORT: DEG

One Last Look Back at A Very Good Year

By DOUG WYATT, DEG President

I am reflecting on this past year of the DEG with my feet propped up, iPad in my lap, a cold libation in hand – and I am smiling.

Our industry and Association are critical to the advancement of humankind and a bridge for international relationships while growing increasingly in environmental sync with our planet. We have good people doing good work for a good cause.

I am smiling because I know that the DEG has been a large part of this effort. Consider these successes:

- ▶ Our membership has grown by 15 percent.

Our AAPG members see the value of environmental considerations in oil and gas production – and especially in unconventional. This growth has been both in the United States and internationally.

- ▶ Our technical sessions during the ACE, ICE and Section meetings were very well attended – often standing room only – with important, useful and relevant topics.

And our luncheons and speakers have been outstanding.

- ▶ Our DEG leadership team has



WYATT

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completed the draft of a white paper on hydraulic fracturing that is eagerly awaited by many as a potential tool.

- ▶ There is increasing readership and citations of *Environmental Geosciences* because of the quality of our technical content, and our field trips and short courses are well-attended.

- ▶ We have a special topics technical symposium planned for 2015 on the environmental considerations of hydraulic stimulation.

- ▶ Our DEG Executive and Advisory committees are committed, active and engaged in the organization, government and industry, and are comprised of highly qualified individuals who work effectively as a team. This is a gift to any organization.

And lastly ...

- ▶ Our members are actively engaging the public by providing knowledge and skills supporting environmental considerations for improved and efficient oil and gas production.

* * *

As a final thought I was considering our name, Division of Environmental Geosciences, and researching the meaning and history of the words by which we call ourselves.

I am not sure why – maybe it's the libation, maybe I'm just being philosophical – but the words interested me.

"Division," from Old Latin *divisio* meaning "to divide," first used in English about A.D. 1375, with a variety of modern

meanings ranging from "the process or act of dividing," "being separated out," to "a difference of opinion that causes a separation," to "being a smaller part of a larger whole," and even a meaning in logic statements.

"Of" may be the most complicated word: A simple preposition, in use before A.D. 900 and a variant of Old English, German, Latin and Greek. However, it has the powerful function to indicate the relation between words and phrases.

"Environmental" is an interesting word – in our case an adjective, older than I thought, from "environs" about A.D. 1600, first used as "environment" in 1827, and first used to include a specialized ecology sense in 1956.

In general, it means "all the external conditions and circumstances surrounding a person, place or thing." It is a very broad term.

Lastly, "Geosciences" is a new term, from 1940-45, meaning collectively any science, such as geology, geophysics, geochemistry or geodesy, concerned with the earth; an earth science.

Generally, the older the word, the more meanings it has. The various definitions of the words in the name "Division of Environmental Geosciences"

See DEG, page 53



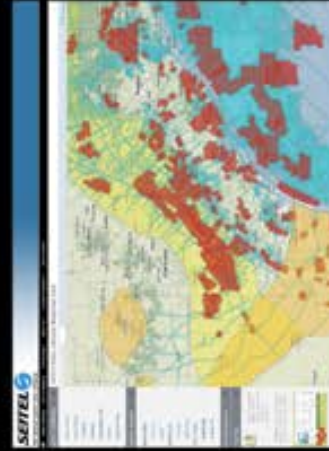
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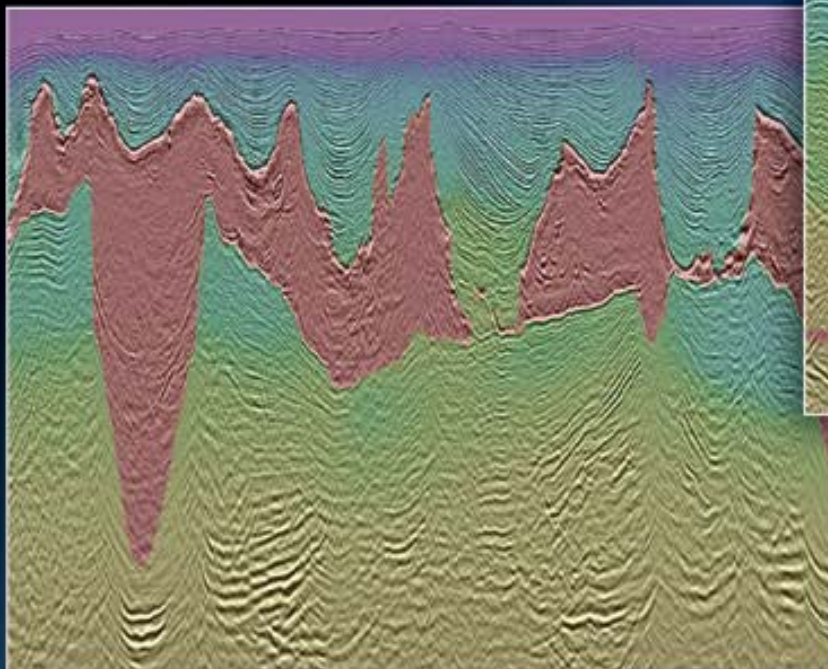
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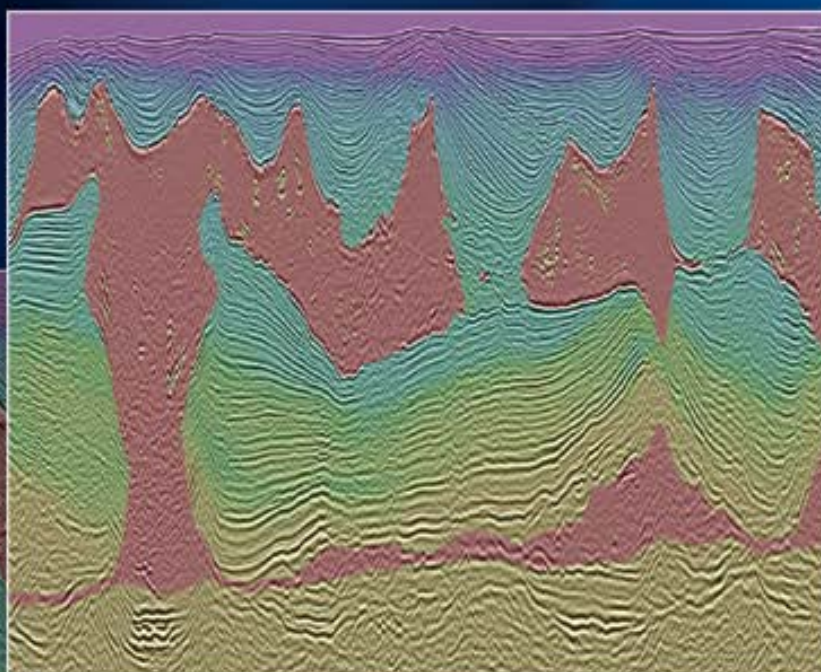
Multiclient

Acquisition by WesternGeco

Conventional
Velocity Model E-Dog 2006



Revolution
Model 2013



A comparison of conventionally acquired narrow-azimuth data from 2006 (left) and full-azimuth data acquired and processed for the Revolution survey in 2013 (right). The new data allows better delineation of the subsalt structure and accurate reservoir definition to help mitigate drilling risk.

Illuminate beyond the salt with the latest high-resolution Gulf of Mexico data.

Schlumberger Revolution multiclient seismic surveys integrate more than 27,000 km² of ultralong-offset seismic data obtained using WesternGeco Dual Coil Shooting* multivessel full-azimuth acquisition. Acquired and processed using the latest technology and interpreted with deep geoscience expertise, Revolution survey data allows you to visualize the salt-sediment interface, map the Mesozoic section, and see deeper into the reservoir.

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